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AN EXPANSION OF PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE PHYSICAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY AND PALEONTOLOGY
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THE FAUNA OF THE PITKIN FORMATION OF ARKANSAS¹

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ABSTRACT.—The Pitkin formation is a thick, predominantly limestone sequence of strata in northern Arkansas characterized by a unique and isolated fauna probably of Clore and younger age. The fauna is briefly discussed, a faunal list is given, and new species are described as follows: 4 corals, 1 blastoid, 1 stelleroid, 11 bryozoans, 4 brachiopods, 4 gastropods, and 1 cephalopod. At present 208 species are known from the Pitkin.

INTRODUCTION

THE IDENTITY of the Pitkin formation of Arkansas was first recognized by D. D. Owen, who termed it the "Archimedes limestone," but it was named the "Pitkin limestone" by E. O. Ulrich in 1904 from exposures presumably near the town of Pitkin (now called Woolsey), but no precise type locality was specified. Actually, the Brentwood limestone member of the Bloyd shale (Morrow Group) is the most conspicuous unit cropping out at Pitkin and it is probable that the type locality of the Pitkin formation is at the conspicuous bluff along highway 71 three-quarters of a mile southeast of the town of West Fork, Arkansas, in the W $\frac{1}{2}$, NW $\frac{1}{4}$ sec. 4, T. 14 N., R. 30 W. Although commonly described as a limestone, the Pitkin has been shown (Easton, 1942) to include a considerable proportion of shale and some lenticular sandstone bodies.

The Pitkin formation extends from near Muskogee, Oklahoma, where it occurs in scattered outcrops, to the vicinity of Batesville, Arkansas. It crops out continuously

across the north escarpment of the Boston Mountains, with the thickness varying from about 20 feet in western Arkansas to a possible maximum over 400 feet in Searcy County. Farther east it thins to where the Boston Mountains terminate at the Mississippi Embayment and the formation is no longer fully exposed. There is also thickening from the north, where the formation is partly conglomeratic, to the south. The northern shore of the Pitkin sea probably lay not far north of the present northern limit of outcrop.

Most strata within the Pitkin are locally very fossiliferous, the upper portions being the most fossiliferous of all. Snider (1915) was the first to describe species from this formation and Girty (1929) and Laudon (1941) subsequently have added new species. The fauna has either been examined or referred to by Croneis, C. A. Moore, Purdue and Miser, Roth, Sutton, and Ulrich.

Because the Pitkin is the youngest Chester formation in Arkansas, it is important that its fauna be well understood in order to deal competently with the problem of the Mississippian-Pennsylvanian boundary. In northwestern Arkansas the Pitkin typically

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is overlain by the Hale sandstone and underlain by the Fayetteville shale but eastward from Newton County the contact between the Pitkin and the Morrow strata is exceedingly difficult to recognize, therefore, this paper is chiefly concerned with the Pitkin fauna of the western area.

ACKNOWLEDGEMENTS

The fossils upon which this study has been made were collected during the course of stratigraphic investigations conducted for the Arkansas Geological Survey under the direction of Mr. G. C. Branner. The material was studied at Walker Museum, University of Chicago, under the guidance of Mr. Carey Croneis, who suggested the problem and has aided inestimably in its study. Messrs. R. S. Bassler, C. L. Cooper, G. A. Cooper, M. Gordon, Edwin Kirk, J. B. Knight, A. K. Miller, E. C. Olson, A. H. Sutton, and J. M. Weller, have kindly identified specimens, checked identifications, and offered helpful suggestions.

FAUNAL RELATIONS AND CORRELATIONS

The late Chester age of the Pitkin formation is well established by a comparison of its fauna with the Chester faunas of Illinois. The upper Chester is characterized in part by the presence of *Composita subquadrata*, *Eumetria costata*, *Buxtonia arkansana*?, and *Glyptopleura inoptina*, to mention only those species which occur in both the upper Chester of Illinois and in the Pitkin. The Pitkin fauna, however, is composed not only of typical upper Chester species, but also of some species characteristic of overlying Pennsylvanian beds and others that are typical of strata older than the upper Chester. As in the Chester faunas of Illinois, there are many species that have a long Chester record. The chief faunal characteristics of the Menard, Clore, and Kinkaid limestones of Illinois, as indicated by Stuart Weller (1920) are given below.

In the Menard limestone occur *Pentremites fohsi*, *Pterotocrinus menardensis*, abundant spinose summit plates of *Hydreionocrinus*, *Archaeocidaris* plates, and a large coarse form of *Spirifer increbescens*. *Composita subquadrata* replaces the earlier Chester *Composita trinuclea* in this formation and *Eumetria costata* replaces the earlier

Eumetria vera. *Sulcatopinna missouriensis* is most common in the Menard.

The Pitkin formation contains *Pentremites*, *Pterotocrinus*, *Hydreionocrinus*, and *Archaeocidaris*, but these elements are not of great value unless known specifically. *Spirifer increbescens* and *Sulcatopinna missouriensis* are apparently lacking, but *Composita subquadrata* and *Eumetria costata* are both present.

In the Clore limestone *Composita subquadrata* and *Spirifer increbescens* are associated with *Buxtonia arkansana*?. *Batostomella nitidula* is a conspicuous element and is locally very abundant, whereas *Glyptopleura inoptina* is known in Illinois only from the Clore. *Rhombopora* is common.

The presence in the Pitkin of *Buxtonia arkansana*, *Composita subquadrata*, *Glyptopleura inoptina* (of which more later), and species of *Batostomella* and *Rhombopora* indicate more similarity between the Clore and Pitkin than between the Menard and Pitkin.

The fauna of the Kinkaid is characterized by the return of *Composita trinuclea*, which is associated with *Martinia contracta* and *Sulcatopinna missouriensis*.

The Pitkin contains *Composita trinuclea*, *Martinia*, and also *Composita subquadrata*, the last of which is not known from the Kinkaid. This unusual circumstance, the recurrence of *Composita trinuclea*, is shared by both the Kinkaid and Pitkin, but the occurrence of *Composita subquadrata* must be explained at present as a holdover in the Pitkin.

Glyptopleura inoptina, the types of which were collected about 20 feet above the base of the Fayetteville shale, has been found in Illinois only in the Clore, according to C. L. Cooper (1941, p. 11). The species also occurs near the base of the Pitkin in western Arkansas (which is well up in the total aggregate of the formation), therefore, several hundred feet of strata occur between the Fayetteville and Pitkin occurrences. The correlation of the Clore with either the Pitkin of western Arkansas or part of the lower portion of the Fayetteville shale is indicated, in either of which cases, the Pitkin must be very late Chester.

Several Pitkin elements are of decided Pennsylvanian aspect. *Euasianites* n. sp. is very similar to *E. oblatius* from the Morrow

of Arkansas and may be ancestral to the latter, as A. K. Miller has indicated that the Pitkin species is the more primitive.² *Euphemites* n. sp., though known from other Chester beds, is widely present in the Pennsylvanian. *Hemizygia* is typically found in the Upper Carboniferous. *Delocrinus* is typically Upper Carboniferous, and Laudon (1941, p. 384) has already mentioned the Upper Carboniferous aspect of the Pitkin crinoids, all but one of which are Inadunata. *Pleurodictyum eugenei* has heretofore been thought to have been restricted to the Pennsylvanian. *Dielasma arkansanum* and *Eumetria vera* are known from Mississippian and Pennsylvanian beds. Altogether, 64 genera, or half of the 130 recognized genera represented in the Pitkin fauna are known to occur in Pennsylvanian strata; this would indicate a late Chester age for the Pitkin formation, although it is inconclusive proof.

Several elements of the Pitkin fauna are typical of much older strata. *Syringothyris* n. sp. represents a genus characteristic of rocks of Kinderhook through Keokuk age. In the Mississippian, *Pustula* and *Krotavia* were known only from the Kinderhook to Burlington and from Kinderhook strata, respectively, although a Pennsylvanian species of each has been described. *Aganaster* is typical of part of the Borden group. *Amplexus* has a long range from Devonian to Pennsylvanian, but is most characteristic of the Lower Mississippian or Iowan series. *Holopea newtonensis*, if it really occurs in the Pitkin is relict from the Iowan series. *Griffithides*, also of doubtful Pitkin occurrence, is indicative of older strata. *Dolorthoceras eurekensis* is known from pre-Pitkin strata. *Agassizocrinus*, *Camarophoria explanata*, and the several species of *Archimediopora* are more typical of older Chester strata in Illinois, although they do carry upward in less abundance.

The writer assigns the Pitkin to the upper Chester and believes that its lower part is no older than the Clore. The Pitkin probably includes not only the Kinkaid, but also strata younger than any part of the Chester series of Illinois.

Snider (1915, p. 43) correlated the Pitkin with the Maxville limestone of Ohio and

through the Maxville with the Greenbrier limestone. The writer agrees with Morse (1910, p. 108) that the Maxville is probably equivalent, at least in part to the Ste. Genevieve limestone, thus, the Greenbrier cannot be equivalent to the Pitkin. The upper Greenbrier contains some Chester beds but none as young as those of the Pitkin. The Carterville limestone of Missouri, which has been suggested as a possible correlative of the Pitkin by Snider (1915, p. 43), is lower Chester.

Beds of Pitkin age are probably included in the Chester of the Appalachians but the faunas of these eastern beds are not sufficiently well known to permit accurate correlations. Butts (1927) considered that the Parkwood bridges the Mississippian-Pennsylvanian boundary and that the basal Parkwood is equivalent to the upper part of the Pennington formation of eastern Tennessee, which, in turn, is equivalent to part of the Floyd shale. He (1927, chart opposite p. 80) considered the Floyd shale of Alabama to be equivalent to the Bangor, Pennington, and Parkwood. With the base of the Floyd placed at the horizon of the Glen Dean, it is obvious that the Pitkin is equivalent to part of the Floyd, because the top of the Floyd is uppermost Chester. It cannot be determined at present what part of the Floyd is equivalent to the Pitkin, but the Pitkin is presumably younger than the Bangor limestone or parts of the Floyd equivalent to the Bangor.

Although the Paradise formation of Arizona contains several species in common with the Pitkin, Hernon concluded (1935, p. 663) that the Paradise probably was no younger than part of the Glen Dean.

The White Pine shale of Nevada and the Pitkin contain two cephalopod species that are closely similar, if not conspecific, but a correlation based on the meager fauna of the White Pine can not be definite.

Bell (1929, pp. 66-68) gave a faunal list of the Windsor of Canada, which is of decided European character, but correlations with the Chester of the Mississippi Valley seem of doubtful validity. It does not seem likely that the fauna of the Windsor sea ever entered the mid-Continent sea of the United States. Instead, the Windsor appears to be typical of European Carboniferous seas.

² Correspondence, April 15, 1940.

Detailed studies of the Carboniferous corals have been made by British paleontologists, whose work has been summarized by Hudson and Turner (1933) in a paper of signal interest to all students of the Lower Carboniferous. The Chester series includes at least the English faunal zones E₁ and E₂ and probably part of the H zone; the Upper Viséan may be equivalent to part of the Chester, also.

Upper Mississippian coral faunas have been reported from China, where, according to Ting and Grabau (1936, p. 560, 561), the Upper Mississippian (Fengninian) or Shangssuan series is marked in the upper portions by the predominance of the coral genera *Syringopora*, *Caninia*, *Lithostrotionella*, and *Kweichouphyllum*. Ting and Grabau regard the fauna as typically Indo-Pacific,

which entered the Eurasian continent in South China and Indo-China and transgressed westward to the extreme western limit of the Continent. The path of the invasion is well shown by the occurrence of this fauna in Kansu Province, Chinese and Russian Turkistan, the Ural region, the Moscow and Donetz Basins, Persia, Asia Minor, and elsewhere.

The unusual coral fauna from the Pitkin is separated from similar occurrences by considerable distances. This fauna probably never existed in the seas which covered southern Illinois during Chester time because not a single one of its genera has been recorded there. Possibly the fauna migrated down the Appalachian or Cordilleran geosyncline and thence into the Pitkin sea.

Surely the Pitkin sea was unique, bearing not only the general long-range Chester species, but relict species, species of Pennsylvanian aspect, foreign coral genera, and several rarely found genera of invertebrates.

NATURE AND SOURCE OF THE FAUNA

The characteristics of the Pitkin fauna are as follows:

1. A few species are of decided upper Chester age.
2. The fossils are, for the most part, of long Chester range and wide geographic distribution.
3. A few species occur in the Pennsylvanian and half the genera carry over into the Pennsylvanian.

4. A few other species are not known from the Pennsylvanian, but are suggestive of more advanced development than other Chester elements.

5. A few species are characteristic of earlier Chester strata and some species are closely related to or reminiscent of species from the Iowa series.

6. Individual faunal elements which would provide bases for correlating the Pitkin with some definite portion of the type Chester of the Illinois Basin are largely absent, therefore, the fauna appears to be geographically isolated.

7. Some species are unlike other known Chester fossils from the United States, but are related to certain foreign species.

8. The fossils occur abundantly at some localities but are not necessarily restricted enough to allow constructive zoning of the formation at this time.

The writer views the Pitkin sea as being a lobe of an ocean lying south of North America. In this sea the Chester faunas evolved and from it they migrated northward from time to time and the Pitkin fauna seems to record the last migration during the Mississippian period in the mid-Continent. This ocean probably endured from earliest Mississippian time and as late as Pitkin time contained relict elements of early Mississippian age. The Pitkin sea, occupying a separate basin from that of the Illinois basin, was probably sufficiently isolated geographically for the fauna to possess marked differences from the northern Chester faunas. Long range Chester species occurred in both basins, but certain distinctive guides present abundantly in Illinois are absent in Arkansas. The writer believes faunas of Pennsylvanian aspect were appearing as the last of the early Mississippian faunas were dying out, and that this condition was attained during Pitkin or late Chester time. Furthermore, faunal migration from Europe or Asia apparently reached this ocean and certain corals of unique aspect migrated northward with the Pitkin sea but were unable to cross into the Illinois basin.

Such a situation might have existed if the two basins were separated by a barrier connecting the Ozark and Nashville domes, or if a marine connection between the south-

ern and the northern (Illinois) basins were unenduring and different environments acted as an ecologic barrier. Certainly a connection existed in lower Chester time, but there appears to be no evidence that the two basins were directly joined in Pitkin time.

The recurrence of certain Mississippian species in the Morrow group can be explained similarly, on the basis of a parent ocean lying south of the present Boston Mountains. The Hale sandstone and conglomerate was deposited in a shallow post-Pitkin sea by currents capable of transporting coarse sediments and of partially reworking Pitkin sediments and their fossils. In the meantime, most, but not all of the Mississippian elements in the parent ocean had died out and true Pennsylvanian forms were added to the assemblages which typified post-Hale strata. That considerable time would be necessary to accomplish the faunal break, is evident, even though the unconformity is not structurally apparent.

FAUNAL SUMMARY

	Genera Identified	Total De- scribed Species	Newly De- scribed Species	Total Species
Foraminifera	1	0	0	1
Porifera	1	0	0	1
Anthozoa	8	8	4	11
Blastoidea	1	2	1	3
Crinoidea	15	7	0	23
Stelleroidea	2	1	1	2
Echinoidea	1	0	0	1
Vermes	1	0	0	1
Bryozoa	15	24	11	30
Brachiopoda	27	38	4	48
Pelecypoda	17	22	0	35
Scaphopoda	1	0	0	1
Gastropoda	24	9	4	30
Cephalopoda	6	5	1	9
Trilobita	3	3	0	4
Ostracoda	3	2	0	3
Vertebrata	4	0	0	4
Plantae	0	0	0	1
Totals	130	121	26	208

The faunal summary presented in tabular form classifies the 208 species now known from the Pitkin. Every fossil form not demonstrably a synonym or homonym has been counted. *Linoproductus prattenianus*,

Eumetria marcyi, and *Allorisma arkansana*, all of which have been included in the fauna previously, are, in the opinion of the writer, synonyms of species already included. *Productus elegans* and *Linoproductus ovatus* are homonyms of other species and are therefore omitted. Previous works by Snider (1915) and Roth (1929) listed 64 and 50 species respectively.

SYSTEMATIC DESCRIPTIONS

Phylum COELENTERATA

Class ANTHOZOA

Order TETRACORALLA

Family CLISIOPHYLLIDAE

Genus KONINCKOPHYLLUM Thomson and
Nicholson, 1876KONINCKOPHYLLUM TALONATUM Easton,
n. sp.

Plate 21, figures 3-7

External character.—Corallum simple to compound, fasciculate, cerioid; peripheral increase conspicuous. Simple coralla turbinate, apical angle about 60°; conical form predominating, little or no cylindrical development. Epitheca not reflecting septa, marked by fine encircling lines and wrinkles; talon very conspicuous. Calyx rather broad, flaring, marked by much thickened counter-cardinal septum rising above the floor; 38 to 42 major septa lining walls. Simple coralla range in length from 3 to 5 cm.

Transverse section.—Dissepimentarium occupying one-half to two-thirds of radius, consisting of small rather V-shaped dissepiments somewhat loosely arranged. Tabularium narrow, marked by one or several ranges of transected tabulae; thickened columellar plate extending part way into well-developed cardinal fossula; cardinal septum short; major septa extending three-quarters of way to axis, equally thickened within tabularium. Septa less well defined in dissepimentarium, where they break up into diverging sides of dissepiments. Cardinal-counter septum continuous in younger stages, may be joined axially by alar septa. Dissepiments mostly concentric in young stages, become angular in mature stages.

Longitudinal section.—Dissepiments dense, steeply inclined. Periaxial tabulae slightly sloping distally or nearly flat; axial tabellae sharply produced distally forming angle of

FAUNAL CHART

	Occurrence	First report	Deposited	Menard	Clore	Kinkaid	Pennsylvanian
FORAMINIFERA							
<i>Endothyra</i> sp.	r	x	W				G
PORIFERA							
<i>Cliona</i> sp.	r	x	W				?
ANTHOZOA							
<i>Amplexus</i> sp.	r	x	W				G
<i>Aulopora</i> cf. <i>A. gracilis</i> Thomson	r	x	W				
<i>Caninostrotion variabilis</i> , n. sp.	a	x	W				
<i>Koninckophyllum talonatum</i> , n. sp.	c	x	W				
<i>Lonsdaleia major</i> , n. sp.	r	x	W				
<i>Lonsdaleia minor</i> , n. sp.	r	x	W				
<i>Pleurodictyum eugenei</i> (White)	r	x	W				x
<i>Pleurodictyum meekanum</i> (Girty)	c	x	W				
<i>Syringopora</i> sp.	r	x	W				G
<i>Triplophyllum spinulosum</i> (Edwards and Haime)	a	x	W	x	x	x	
Cup coral unidentified.	r	x	N			x	
BLASTOIDEA							
<i>Pentremites</i> sp.	c	x	W		G	G	G
<i>Pentremites laminatus</i> , n. sp.	c	x	W				
<i>Pentremites</i> cf. <i>P. platybasis</i> Weller	r	x	W				
CRINOIDEA							
<i>Agassizocrinus</i> sp. 1.	r	x	W		G	G	G
<i>Agassizocrinus</i> sp. 2.	r	x	W				
<i>Agassizocrinus</i> sp. 3.	r	x	W				
<i>Carcinocrinus stevensi</i> Laudon	r		T				
<i>Catilocrinus</i> sp.	r		T				
<i>Cosmetocrinus</i> sp.	r		T				
<i>Cromyocrinus</i> sp.	r	x	W				
<i>Cyathocrinus</i> sp.	r	x	N				
<i>Delocrinus</i> sp.	r	x	W				G
<i>Hydreionocrinus</i> sp.	r	x	W			G	G
<i>Linocrinus floweri</i> Laudon	r		T				
<i>Pachylocrinus</i> sp.	r	x	W				G
<i>Pelecocrinus stereosoma</i> Laudon	r		T				
<i>Phanocrinus cooksoni</i> Laudon	r		T				
<i>Phanocrinus</i> cf. <i>P. cooksoni</i> Laudon	r	x	W				
<i>Poteriocrinus</i> ? sp.	r	x	N				
<i>Pterotocrinus</i> sp.	r	x	W		G	G	
<i>Scytalocrinus</i> sp. 1.	r		T				
<i>Scytalocrinus</i> sp. 2.	r		T				
<i>Scytalocrinus braggi</i> Laudon	r		T				
<i>Scytalocrinus dunlapi</i> Laudon	r		T				
<i>Scytalocrinus garfieldi</i> Laudon	r		T				
Crinoid unidentified.	r	x	W				
STELLEROIDEA							
<i>Aganaster cingulatus</i> , n. sp.	r	x	W				
<i>Schoenaster</i> ? sp.	r	x	W				
ECHINOIDEA							
<i>Archaeocidaris</i> sp.	c	x	W		G	G	G
VERMES							
<i>Spirorbis</i> sp.	c	x	W				G
BRYOZOA							
<i>Anisotrypa solida</i> Ulrich	c	x	W				G
<i>Archimediopora</i> sp.	a		W		G	G	G
<i>Archimediopora communis</i> (Ulrich)	c	x	W				
<i>Archimediopora distans</i> (Ulrich)	r	x	W			x	
<i>Archimediopora intermedia</i> (Ulrich)	c	x	W				
<i>Archimediopora invaginata</i> (Ulrich)	a		W				
<i>Archimediopora proutana</i> (Ulrich)	c	x	W			x	

FAUNAL CHART—Continued

	Occurrence	First report	Deposited	Menard	Clore	Kinkaid	Pennsylvanian
<i>Archimediopora swallowana</i> (Hall)	a		W				
<i>Batostomella</i> sp.	c	x	W		G	x	G
<i>Chilotrypa regularis</i> , n. sp.	r	x	W				
<i>Dichotrypa levis</i> , n. sp.	r	x	U				
<i>Dyscritella</i> ? sp.	r	x	W				
<i>Fenestella</i> [<i>Fenestrellina</i>] sp.	c	x	W		G	G	G
<i>Fistulipora introspinosa</i> , n. sp.	c	x	W			G	G
<i>Glyptopora michelinia</i> (Prout)	?		U				G
<i>Glyptopora crassa</i> , n. sp.	a	x	W				
<i>Lyropora solida</i> , n. sp.	r	x	W			G	
<i>Meekopora abrupta</i> , n. sp.	a	x	W			G	
<i>Meekopora tenuis</i> , n. sp.	a	x	W				
<i>Polypora</i> sp.	a	x	W				
<i>Polypora</i> cf. <i>P. whitei</i> Ulrich	c	x	W				
<i>Rhombopora</i> sp.	r	x	W		G	G	G
<i>Septopora</i> cf. <i>S. biserialis</i> Swallow	c	x	W				G
<i>Septopora cestriensis</i> Prout	c	x	W		x	x	
<i>Septopora subquadrans</i> Ulrich	c	x	W				
<i>Tabulipora cestriensis</i> (Ulrich)	a	x	W		x	x	G
<i>Tabulipora microfistulata</i> , n. sp.	a	x	W			G	
<i>Tabulipora poculoformis</i> , n. sp.	r	x	W				
<i>Tabulipora reflexa</i> , n. sp.	c	x	W				
<i>Tabulipora subtilis</i> , n. sp.	r	x	W				
BRACHIOPODA							
<i>Athyris cestriensis</i> Snider	r		W				?
<i>Buxtonia arkansana</i> (Girty)	a		W		x		
<i>Camarophoria cestriensis</i> Snider	a		W				
<i>Camarophoria explanata</i> (McChesney)	c		U	x	x	x	
<i>Chonetes oklahomensis</i> Snider	a		W				G
<i>Chonetes sericeus</i> Girty	?		W				
<i>Chonetes tumescens</i> , n. sp.	a	x	W				
<i>Clothyrindina sublamellosa</i> (Hall)	a		W	x	x	x	
<i>Composita subquadrata</i> (Hall)	c		W		x	x	G
<i>Composita trinuclea</i> (Hall)	c		W	x			
<i>Composita</i> sp.	?						
<i>Crania infimbriata</i> , n. sp.	r	x	U		G	G	G
<i>Diaphragmus</i> ? sp.	?						
<i>Dielasma</i> ? sp.	r	x	W				
<i>Dielasma arkansanum</i> Weller			I				
<i>Dielasma formosum</i> (Hall)	?		U				
<i>Dielasma illinoisensis</i> Weller	c	x	W				
<i>Dielasma shumardanum</i> (Miller)	r		W		x	x	
<i>Dielasma whitfieldi</i> Girty	a	x	W				
<i>Echinoconchus alternatus</i> (Norwood and Pratten)	a		W				
<i>Echinoconchus</i> ? sp.	r	x	W				
<i>Eumetria costata</i> (Hall)	c		W	x	x	x	
<i>Eumetria pitkinensis</i> Snider	c		W				
<i>Eumetria vera</i> (Hall)	c		W				x
<i>Girtyella indianensis</i> (Girty)	r		U				
<i>Hustedia</i> sp.	r	x	W				G
<i>Hustedia multicostata</i> Girty	c		W				
<i>Krotavia lucerna</i> , n. sp.	r	x	W				
<i>Lingula</i> sp.	r	x	U				G
<i>Lingulidiscina newberryi</i> var. <i>moorefieldana</i> Girty	?						G
<i>Lingulidiscina newberryi</i> var. <i>ovata</i> Girty	?						
<i>Linoproductus pileiformis</i> (McChesney)	a		W	x	x	x	
<i>Martinia</i> sp.	r	x	U	x			
<i>Orthotetes kaskaskiensis</i> (McChesney)	c		W	x	x	x	G
<i>Orthotetes kaskaskiensis</i> var. ?	r	x	W				

FAUNAL CHART—Continued

	Occurrence	First report	Deposited	Menard	Clore	Kinkaid	Pennsylvanian
<i>Orthotetes subglobosus</i> var. <i>protensa</i> Girty	c	x	W				
<i>Orthotetes suspectum</i> (Girty)	c		W				
<i>Productus cestriensis</i> Worthen	a		W	x	x	x	G
<i>Productus fasciculatus</i> McChesney	r		W				
<i>Pustula</i> ? sp.	r	x	W				
<i>Reticularia setigera</i> (Hall)	a		W				
<i>Spirifer leidy</i> Norwood and Pratten	a		W	x	x	x	G
<i>Spirifer pellaensis</i> Weller	a		W				
<i>Spiriferina spinosa</i> (Norwood and Pratten)	r		W		x	x	G
<i>Streptorhynchus</i> ? sp.	r	x	W				
<i>Syringothyris aequalis</i> , n. sp.	c	x	W				
<i>Tetracamera</i> sp. (<i>T. neogenes</i> ?)			U				
<i>Tetracamera neogenes</i> Girty	c		W				
PELECYPODA							
<i>Allorisma walkeri</i> Weller	c		W				G
<i>Astartella</i> sp.	r	x	U				G
<i>Aviculopecten batesvillensis</i> Weller	?		W	G			G
<i>Aviculopecten eurekaensis</i> Walcott	?						
<i>Aviculopecten keoughensis</i> Snider	r		W				
<i>Aviculopecten morrowensis</i> Girty	r		W				
<i>Aviculopecten multilineatus</i> Girty	r		U				
<i>Aviculopecten pitkinensis</i> Snider	r		W				
<i>Conocardium</i> sp.	r	x	U				
<i>Conocardium peculiare</i> Girty	?						
<i>Cypricardella</i> sp.	r	x	U				
<i>Cypricardinia</i> sp.	r	x	W				G
<i>Edmondia crassa</i> Girty	?						G
<i>Edmondia crassa</i> var. <i>suborbiculoidea</i> Girty	r		W				
<i>Edmondia pitkinensis</i> Snider	c		W				
<i>Leda</i> sp.	r	x	U				G
<i>Leda vaseyana</i> (McChesney)	r		W				
<i>Leiopteria</i> ? sp.	r		W				
<i>Leptodesma</i> ? sp.	r	x	U				
<i>Myalina</i> sp.	a	x	W			G	G
<i>Myalina compressa</i> Snider	c		W				
<i>Myalina longicardinalis</i> Snider	a		W				
<i>Nucula illinoisensis</i> Worthen	r		W				G
<i>Parallelodon</i> sp.	r	x	W				G
<i>Pteronites</i> sp.	r	x	U				
<i>Schizodus</i> sp. 1	r	x	W				G
<i>Schizodus</i> sp. 2	r		W				
<i>Schizodus arkansanus</i> (Weller)	c		W	x		G	
<i>Schizodus chesterensis</i> Meek & Worthen	?		W				
<i>Schizodus depressus</i> Worthen	r		W				
<i>Schizodus insignis</i> Drake	?		W				
<i>Solenomya</i> ? sp.	r		W				G
<i>Sphenotus cherokeeense</i> Snider	c		W				G
<i>Sphenotus gibsonense</i> Snider	c		W				
<i>Sphenotus quadriplicatum</i> Snider	c		W				
SCAPHOPODA							
<i>Laevidentarium</i> sp.	r	x	W				
GASTROPODA							
<i>Bellerophon</i> sp. 1	r		W	G	G		G
<i>Bellerophon</i> sp. 2	r	x	W				
<i>Bellerophon pitkinensis</i> Snider	c		W				
<i>Bucanella</i> ? sp.	r	x	U				
<i>Colpites</i> ? sp.	r	x	W				G
<i>Euphemites incarinatus</i> , n. sp.	r	x	W				G
<i>Clabrocingulum</i> sp.	r	x	W				

FAUNAL CHART—Continued

	Occurrence	First report	Deposited	Menard	Clare	Kinkaid	Pennsylvanian
<i>Gosseletina</i> ? sp. 1.	r	x	U				
<i>Gosseletina</i> ? sp. 2.	r	x	N				
<i>Helcionopsis</i> ? <i>reticulatus</i> , n. sp.	r	x	W				
<i>Hemizyga</i> sp.	r	x	W				G
<i>Holopea newtonensis</i> Whitfield	?						
<i>Latischisma</i> ? sp.	r	x	N				
<i>Leptoptygma</i> sp.	r	x	W				G
<i>Leptoptygma</i> ? sp.	r	x	U				
<i>Microptychis</i> sp.	r	x	W				
<i>Mourlonia angulata</i> , n. sp.	r	x	U				
<i>Naticopsis</i> sp.	r	x	U	x			G
<i>Neilsonia</i> sp.	r	x	N				
<i>Phanerotrema</i> sp.	r	x	W				G
<i>Platyceras subrotundum</i> Snider	a		W				G
<i>Pseudozygopleura</i> ? sp.	r	x	U				
<i>Sphaerodoma subcorpulenta</i> (Whitfield)	?		W				G
<i>Siegocoelia</i> sp.	r	x	U				
<i>Straparolus planidorsatus</i> (Meek and Worthen)	r		W				G
<i>Straparolus triliris</i> , n. sp.	r	x	W				
<i>Strobeus</i> sp.	r	x	U				
<i>Strobeus</i> ? sp.	r	x	N				
<i>Strophostylus</i> sp.	r		W				G
<i>Conularia</i> sp.	r	x	W			G	G
CEPHALOPODA							
<i>Coloceras</i> [<i>Leuroceras</i> ?] sp. 1.	r		W				G
<i>Coloceras</i> sp. 2.	r	x	W				
<i>Cravenoceras</i> cf. <i>C. hesperium</i> Miller and Furnish	r	x	U				
<i>Cycloceras randolphensis</i> (Worthen) ?	r		W				
<i>Cycloceras sequoyahensis</i> Snider	r		W				
<i>Dolorthoceras</i> ? <i>eurekaensis</i> (Walcott) ?	r		W				G
<i>Dolorthoceras</i> ? sp.	r	x	W				
<i>Eoasianites globosus</i> , n. sp.	r	x	W				G
<i>Mooreoceras</i> sp.	r		I				G
TRILOBITA							
<i>Griffithides</i> sp.	?						
<i>Griffithides pustulosus</i> Snider	?						
<i>Kaskia chesterensis</i> J. M. Weller	c	x	W				
<i>Paladin mucronatus</i> (Girty)	a		W				
OSTRACODA							
<i>Glyptopleura inoptina</i> Girty	r	x	N				G
<i>Paraparchites</i> sp.	r	x	U				G
<i>Primitia fayettevillensis</i> Girty	r	x	U				
VERTEBRATA							
<i>Cladodus</i> sp.	r	x	W				
<i>Deltodus</i> sp.	r	x	W				
<i>Petalodus</i> sp.	r	x	W				
Spine, unidentified	r	x	U				
PLANTAE							
Encrusting alga	r	x	W				

KEY

r—rare
c—common
x—first report or species present
a—abundant
?—doubtful
G—genus present

W—Walker Museum
U—U.S. Geological Survey
T—University of Tulsa
I—State University of Iowa
N—National Museum

about 45 to 60 degrees with thickened median plate; density of tabulae about 12 in 0.5 cm.

Comparison.—This species differs from *K. magnificum* in the more acute axial tabellae, broader dissepimentarium, thicker median plate, and fewer septa. It differs from *K. interruptum* chiefly in the persistent median plate, broader dissepimentarium, and septa of nearly equal strength.

Types.—Holotype, U. C. 48257 from locality 10; ideotype, U. C. 48259 from locality 6.

Family CANINIIDAE

Genus CANINOSTROTION Easton, n. gen.

Diagnosis.—Compound rugose corals multiplying asexually chiefly by "peripheral increase" but possibly also by basal division. Cardinal fossula conspicuous in all but early stages, formed by down-bending of tabulae and shortening of cardinal septum. Dissepimentarium broad; dissepiments tend toward angulo-concentric pattern. Pseudocolumella intermittently developed, variable, formed by junction of axial ends of some major septa combined with the distal arching of tabulae. Tabulae strong, irregularly arranged. Typically, septa are equally thickened in all quadrants.

The genus differs from *Caninophyllum* Lewis, 1929 in being compound, in having major septa typically equally thickened in all quadrants, in having a well-developed pseudocolumella, and in having much shorter minor septa than in *Caninophyllum*. It differs from *Bothrophyllum* Trautschold, 1879 in the same manner, but the pseudocolumella is stronger and more persistently present in late stages. The pinnate arrangement of the septa adjacent to the cardinal septum is obscure, if present at all. There is no flattening of tabulae in the adult.

Genotype, *Caninostrotion variabilis*, n. sp.

Occurrence.—Widespread in the Pitkin formation (uppermost Chester) of Arkansas.

CANINOSTROTION VARIABILIS Easton, n. sp.

Plate 21, figures 14–16

External character.—Conical proximally, rapidly attaining cylindrical shape. Talon inconspicuous, sometimes more than one present. Epitheca thin, marked by extremely fine encircling striae; rugae com-

monly present. Calyx subcircular to oval, very deep, floor crossed by major septa, many uniting axially. Cardinal fossula well developed, narrow, typically lying on shorter or inwardly bent side of corallite and not tending towards rotation; other fossulae lacking. Simple specimens range in length from 3 to 8 cm., in width from 1.5 to 4.5 cm. greatest diameter; largest corallum 11 cm. long and 9 cm. in greatest width, with at least three ranges of corallites.

Transverse section.—Major septa in mature regions 38 to 46; cardinal septum usually short, flanked on each side by one or two major septa tending to enclose fossula but not joining ends; major septa typically, but not invariably, equally thickened, one section showing added septal stereozone in cardinal quadrants; thickening only within tabularium, septa tapering axially; ends of a few majors commonly joined at weak pseudocolumella; minor septa not completely crossing into tabularium, except in very young stages; minor septa slightly thinner, more irregular than extrathecal portions of majors. Tabularium occupies one-third or less of radius. Dissepimentarium broad; outer dissepiments very angular for a few rows, most others angulo-concentric, except for the innermost concentric series where dissepiments may be somewhat thickened.

In immature regions, sections show narrow dissepimentarium not present in earliest stages, consisting principally of concentric dissepiments. Fossula less well marked than in advanced stages. In very early stages few major septa always unite at axis and cardinal septum is long and slightly thicker than other septa.

Longitudinal section.—Dissepimentarium absent in very early stages, first represented by single row of vesicles; in mature stages dissepimentarium may occupy two-thirds of radius; outermost dissepiments closely packed; innermost dissepiments less closely packed but noticeably thickened. Inner wall indicated but not invariably present. Active growth stages indicated in dissepimentarium by broadly S-shaped rows of dissepiments. Tabulae highly variable, broadly to sharply arched; tabulae arched axially to meet axial ends of some major septa thereby forming pseudocolumella; density of tabulae

rather irregular about 20 to 22 in 1 cm., some tabulae incomplete.

Comparison.—This species differs from *Bothrophyllum longiseptum* (Lewis), (formerly called *Pseudocaninia*) which it resembles somewhat, in having a more pronounced pseudocolumellar structure, even in mature stages. Its minor septa are located within the dissepimentarium, except occasionally in young stages, and the septal stereozone is not typically greater in the cardinal quadrants than elsewhere.

Types.—Holotype, U. C. 48367 from locality 4; paratype, U. C. 47203 from locality 4; ideotype, U. C. 48272 from locality 3. This is one of the most common Pitkin fossils, occurring at almost every locality, sometimes in great abundance.

Remarks.—Because added septal stereozone in the cardinal quadrant was observed in only one transverse section out of the many dozens observed, this feature must be an aberration here.

Family LONSDALEIIDAE

Genus LONSDALEIA McCoy, 1849

LONSDALEIA MAJOR Easton, n. sp.

Plate 21, figures 11–13

External character.—Corallum compound, massive, cerioid, prismatic in young regions, fasciculate and phaceloid in mature regions. Colony about 15 cm. in diameter, roughly spherical, corallites radiating from center of base. Average diameter of calices varies from 1.5 to 2.0 cm. in mature regions. Epitheca moderately thick with prominent interseptal ridges and fine encircling striae. Calyx depressed periaxially, a calicular boss rising above depressed portion; about 32 major septa present in ephebic portions.

Transverse section.—Dissepimentarium consisting of several rows of large, irregularly shaped dissepiments, septa faintly mirrored within dissepimentarium as ridges on some dissepiments. Lonsdaleioid retreat of septa very pronounced in late mature regions, commonly lacking in early mature regions. An inner wall (sclerotheca) formed by thickening of densely packed dissepiments. Inner zone consists of thickened major septa, about 32 of which extend almost to the axial complex; thin minor septa intercalated between them extend very short distance within sclerotheca. Calicular boss formed of

thin lamellae aligned with major septa and of distally arched tabellae; axial complex resembles spider's web in transverse section.

Longitudinal section.—Dissepiments flatly convex axially, forming one to four rows in dissepimentarium. Inner wall formed by thickening of some dissepimental tissue. Tabulae convex proximally, very thin, sparse. Tabellae very fine, densely packed, arching up steeply, meeting broadly sinuous lamellae. Axial complex occupies from one-third to one-half of radius. Outline of each corallite marked by several evenly rounded swellings not distinct enough to be termed rugae.

Comparison.—This species differs from *Lonsdaleia duplicata duplicata* by having a more fasciculate corallum in ephebic stages, more numerous septa, and smaller dissepiments. It can be distinguished from *L. pictoense* (Billings) by its larger size, much more numerous septa, prominent axial complex, and broad dissepimentarium.

Type.—Holotype, U. C. 48261; locality 48.

LONSDALEIA MINOR Easton, n. sp.

Plate 21, figures 1, 2

External character.—Corallum compound, massive, cerioid, composed of prismatic corallites whose polygonal cross sections vary from three- to seven-sided. Colony 6.2 cm. long, about half as wide, about one-third as thick. Corallites from 3 mm. to 10 mm. in diameter. Holotheca not observed; epitheca thick. Calyx deep, walls steepest near periphery, calicular boss present in axial region. Maximum number of septa observed, 20.

Transverse section.—Epitheca marked by low interseptal ridges. Dissepimentarium occupies at most one-third of radius. Major septa considerably contorted, thickened by sclerenchyme, extending axially short distance from dissepimentarium, most reaching epitheca. Minor septa very short, commonly only twice as long as thickness of epitheca. Dissepiments considerably thickened. Lonsdaleioid retreat of major septa not pronounced; some minor septa reflected on axial side of dissepiments. Periaxial tabulae irregularly located, sparse. Axial tabellae arched distally making a spider's web pattern in conjunction with lamellae. Median

septum quite distinct in young stages.

Longitudinal section.—Dissepimentarium occupies one-third of radius at most; dissepiments large, thin, steeply inclined. Tabulae thin, sparse, broadly arched distally. Tabellae fine, densely packed, contorted, arched steeply distally. Single outer row of dissepiments much thickened, very pronounced.

Comparison.—This species differs from *L. major*, n. sp. in the smaller corallites, fewer and shorter major septa, less broad dissepimentarium, and narrower and simpler axial complex. It differs from *L. floriformis floriformis* in the less broad dissepimentarium, commonly fewer septa, thickened dissepiments, and presence of interseptal ridges.

Type.—Holotype, U. C. 48256; locality 26.

Suborder TABULATA

Family FAVOSITIDAE

Genus PLEURODICTYUM Goldfuss, 1829

Remarks.—Lang, Smith, and Thomas have reported their belief (1940, p. 102) that *Pleurodictyum* is a senior synonym of *Michelinia* de Koninck, 1841. According to these authors (1940, p. 85), the same opinion had been indicated by some authors, but it has not been consistently followed. Hall (1867) apparently considered *Pleurodictyum* to be a subgenus of *Michelinia* (or *Michelina* as Hall spelled it in that publication).

Moreover, Lang, Smith, and Thomas (1940, p. 85) include all the subgenera of *Michelinia* in the synonymy of *Pleurodictyum*; *Eumichelinia* Yabe and Hayasaka, 1915 is included objectively because these three authors chose identical genolectotypes (p. 58) for *Eumichelinia* and *Michelinia*; *Procteria* Davis, 1887 they included subjectively (p. 105); *Protomichelinia* Yabe and Hayasaka, 1915 they included subjectively (p. 107).

Genotype, *Pleurodictyum problematicum* Goldfuss.

PLEURODICTYUM EUGENEI (White)

Michelinia eugeneae WHITE, 1884, 13th Ann. Rept. Indiana Geol. Survey, p. 119, pl. 23, figs. 14–16.

[?] *Michelinia branneri* MILLER and GURLEY, 1894, Illinois St. Mus. Nat. Hist., Bull. 3, p. 68, pl. 7, figs. 12, 13.

Michelinia eugeneae, BEEDE, 1900, Kansas Geol. Survey, vol. 6, p. 21, pl. 2, figs. 12–12b.

[?] *Michelinia eugeneae* [sic]. YAKOVLEV, 1903, Mem. Geol. Comm., N. S., no. 12, pp. 7–15, pl. 1, figs. 3, 5.

Michelinia eugeneae, MATHER, 1915, Bull. Sci. Labs. Denison Univ., vol. 18, p. 95, pl. 1, figs. 17, 17a; pl. 2, fig. 1.

Michelinia eugeneae, EASTON, 1942, Arkansas Geol. Survey, Bull. 8, pl. 1, fig. 4.

Remarks.—*P. eugenei* can be told from *P. meekanaum* by the much smaller size of the corallum and of the corallites and by the very thin tabulae. This species is common in the Morrow but has not hitherto been reported from the Mississippian.

Material.—Walker Museum nos. 48282, 48283, 48284; localities 6, 8, and 23.

PLEURODICTYUM MEEKANUM (Girty)

Michelinia meekana GIRTY, 1910, Ann. New York Acad. Sci., vol. 20, no. 3, p. 189.

Michelinia meekana, SNIDER, 1915, Oklahoma Geol. Survey Bull. 24, pt. 2, p. 71, pl. 3, figs. 9–11.

Phylum ECHINODERMATA

Class BLASTOIDEA

Order EUBLASTOIDEA

Genus PENTREMITES Say, 1820

PENTREMITES LAMINATUS Easton, n. sp.

Plate 21, figures 9, 10

Description.—Body of medium size, height and width very nearly equal; greatest width at distal ends of ambulacra. Dimensions of a well-preserved specimen are: height 13.5 mm., greatest width 14.0 mm., length of ambulacra 13.3 mm., greatest width of ambulacra 3.9 mm.

Dorsal region convex; when seen laterally, outline a broad, low, truncate, pyramid. Stem facet and adjacent trifoliate callosity slightly elevated; latter with lobes and sutures coinciding. Basal plates extend about one-third of distance from center of stem facet to distal parts of ambulacra; each basal with pronounced outward swelling coextensive with dorsal ambulacral regions, not reaching quite as high as stem facet, least prominent swelling on smallest basal. Dorsal ambulacral regions increasingly prominent toward lower ambulacral extremities. Interambulacral areas curving gradually away from ambulacral regions, broadly V-shaped with barely perceptible furrow marking each suture.

Ventral region gently convex with sides sloping to truncate summit. Ambulacral areas about one-third as wide as long, V-shaped in cross-section, side plates most convex distally. Lateral grooves 10 in 3 mm., inclined medially and proximally in distal region, becoming transverse in proximal region. Interambulacral areas increasingly broadly concave below, becoming V-shaped dorsally, proximal ends plate-like, extending somewhat above summit. Lateral margins of interambulacra abruptly and evenly elevated, coalescing to form plate-like proximal ends. Deltoid plates slightly less than one-half as long as ambulacra, sutures straight, meeting at less than 90 degrees.

Comparison.—This species is most closely allied to *P. brevis* Ulrich, differing from it in the smaller basal plates, more elevated stem facet and callosity, narrower and more acutely V-shaped ambulacra, and flat deltoid plates with a plate-like ventral extension. The species differs from *P. platybasis* Weller in its convex dorsal region and its subangular interambulacra with pronounced elevations of the lateral margins.

Types.—Holotype, U. C. 48293; paratypes, U. C. 48294; all from locality 30.

Some specimens of *P. brevis* in Walker Museum exhibit flattened triangular areas in the interambulacra, each being bounded by the lateral ambulacral margin, the adjacent dorsal half of the deltoid suture, and a faint ridge connecting the dorsal point of the deltoid plate and the dorsal extremity of the ambulacra.

Remarks.—*P. laminus* n. sp. occupies a position intermediate between *P. brevis* and *P. platybasis*, at least in most structural details. Specimens from near Leslie, Arkansas, exhibit noticeable growth markings. In young individuals the basal region is produced dorsally, with the callosity and stem facet extending beyond the surface of the basals.

Class STELLEROIDEA
Subclass ASTEROIDEA
Order CRYPTOZONIA

Genus SCHOENASTER Meek and
Worthen, 1860
SCHOENASTER? sp.
Plate 21, figure 8

Remarks.—Only part of one arm is

known; the fragment is 7.0 mm. long and 2.2 mm. wide at the widest place, the distal portion of the fragment being narrower than the proximal part. Nine oval adambulacral plates are present on each half and are alternate in position. The largest of these plates are about 1 mm. long and 0.5 mm. wide. The adambulacra are located with the long axes diagonal to the axis of the ray and are proximally directed. No fewer than 9 spine bases consisting of minute depressions on the adambulacra are arranged linearly toward the distal part of the plates and are aligned ventrally and proximally, hence, the spines pointed distally. The ventral surface is exposed and the ambulacral groove extends at least part way along the arm. No sutures can be observed on the floor of the groove.

This specimen is referred to *Schoenaster*, a genus of true asteroids, but the absence of the disc renders the reference doubtful. In size of plates and proportions of the arm, the Pitkin fragment resembles *S. (?) montanus* Raymond from the Madison limestone of Montana. Although some preparation of the specimen has been attempted, no trace of the disc has been found. The disc of *Schoenaster* is pentagonal and the apex of each angle is orientated in line with a ray.

Material.—U. C. 48292; locality 32.

Genus AGANASTER Miller and
Gurley, 1890

AGANASTER CINGULATUS Easton, n. sp.
Plate 24, figures 9, 10

Disc circular, usually distorted in preservation, greatest diameters of specimens 3.0 mm. to 3.6 mm. Dorsal surface seemingly formed of imbricating plates, arrangement not accurately determinable, probably in two circlets. Indistinct radial swellings seem to coincide with some plates. Body probably comparatively thick because shape of arms is not indicated on dorsal surface. Ventral surface gently convex; two segments of arms extending within periphery of disc, being progressively more incorporated within it. Interambulacral regions consist of polygonal plates; genital slits located beside arms near their origins. Marginalia in vertical band or girdle encircling disc.

Arms subcylindrical, tapering to tips, somewhat depressed dorsally and ventrally,

and presumably capable of considerable lateral, as well as vertical, flexibility. A segment adjacent to disc of one specimen measures 0.49 mm. in length, 0.80 mm. in greatest width, being somewhat narrower proximally. Segments near tips of arms only slightly shorter, much narrower than proximal segments. One isolated arm retains 21 articulated segments, usually fewer are preserved on arms attached to discs. Each segment partially inclosed by paired spineless side plates separated by straight sutures dorsally and ventrally, ventral suture a trifle shorter than dorsal. Dorsal plate triangular or quadrangular, snugly fitting, slightly overlapping adjacent side plates. Ventral plate separated from side plates laterally by narrow clefts.

"Jaws" (actually merely supporting structures) separated from proximal ends of arms by sutures. Tori (separating teeth and jaws) tiny, attached to adjacent members of paired jaws which touch at interambulacral margins, diverge at tips. One jaw measures 0.42 mm. in length. Mouth-angle plates apparently fused to first ambulacrals. No teeth observed.

Comparison.—This species is closely allied to the only other known species of the genus, *Aganaster gregarius* (Meek and Worthen), from the Keokuk beds of Crawfordsville, Indiana. It differs from *A. gregarius* in the consistently smaller diameter of the disc, in possessing longer jaws with straight interambulacral margins, and in the absence of spines or spine bases on its side shields. In this last character the species resembles some European specimens from the "*Cran-gopsis* beds" of Fife which Spencer considered too closely allied to the Keokuk forms to warrant separation.

Types.—Holotype and paratypes on one piece of limestone, U. C. 48291; from locality 24.

Remarks.—The Pitkin specimens definitely show the ventral plate to lie below and to be distinct from the vertebral ossicle. The presence of a ventral plate has not been definitely established heretofore in this genus, and it was thought that it might be absent and that the vertebral ossicle of each segment might be the structure seen.

The material studied consists of 14 relatively complete individuals and many isolated sections of arms. The dorsal side is

exposed on only one specimen. This fact is important from an ecologic standpoint, for today many ophiuroids are burrowing forms which rest with the ventral side up and only have the tips of the arms extending out of the soft bottom deposits. Such a position as this would explain why the fossil Pitkin specimens almost invariably lack the tips of the arms, but are otherwise complete, with the ventral side commonly uppermost. These Pitkin ophiuroids may have been washed into their present location on the slab, but the evidence seems strong that they have weathered out of the rock in the position in which they died.

Phylum MOLLUSCOIDEA

Class BRYOZOA

Group ECTOPROCTA

Order GYMNOLEAMATA

Suborder CYCLOSTOMATA

Family FISTULIPORIDAE

Genus FISTULIPORA McCoy, 1849

FISTULIPORA INTROSPINOSA Easton, n. sp.

Plate 22, figures 1, 2

Zoarium lobate, subramose, or with combinations of these characters. Branches and lamellae from 1 mm. to 5 mm. broad. A colony may attain diameter of one foot or more. Surface with 11 subcircular apertures in 5 mm., no apparent interstitial tissue, maculae, or motticules.

Tangential section.—Zoecia 0.3 to 0.5 mm. in diameter, thick-walled, subcircular to angular, lunaria commonly obscure. Vesicles surrounding zoecia variable in size and distribution, commonly not visible except as broken line or lines. Portions of vesicle walls project into zoecia, giving latter pseudoseptate appearance.

Longitudinal section.—Zoecia curving out from immature region, become relatively straight, meeting surface at about right angles. Diaphragms thin, unperforated, slightly concave, slightly less than one tube diameter apart, occurring throughout length of the zoecia, about 5 in 1 mm. Zoecia thick-walled near surface. Vesicles irregularly placed about 1 to 3 between zoecia, with schlerenchymous deposit on upper surfaces. Walls of vesicles project notably into zoecia as short bars generally inclined distally.

Comparison.—This species differs from

F. excelens Ulrich in having smaller vesicles and in possessing vesicular projections within the zooecia. This latter character also serves to distinguish it from other species of *Fistulipora*. The Pitkin material is not preserved well enough to display all surface details.

Types.—Holotype, U. C. 48197; paratype, U. C. 48198; all from locality 8.

Genus CHILOTRYPA Ulrich, 1884

CHILOTRYPA REGULARIS Easton, n. sp.

Plate 22, figures 3, 4

Zoarium ramose, branches bifurcating, 1 to 2 mm. in diameter. Apertures oval, 5 in 2 mm., in definite oblique ranges and imperfect longitudinal rows, with pronounced peristomes produced proximally into hoods. Interzooecial spaces depressed, smooth, occasional broader areas trending obliquely between zooecia.

Transverse section.—Axial tube subcircular, 0.41 mm. to 0.82 mm. in diameter. About 15 subequal trapezoidal axial zooecia radially surround axial tube, partly bordered outwards by larger irregularly shaped zooecia. First ring of trapezoidal zooecia may be absent in sections near proximal end of zoarium. About 11 large oval zooecia in last ring separated by vesicular tissue typically filled with sclerenchyme near surface. Some of outer zooecia connected by small pores.

Tangential section.—Zooecia oval, about 0.18 mm. by 0.29 mm. in diameter, interspaces filled with small irregularly shaped vesicles in deep sections, by dense sclerenchyme in shallow sections. Zooecial walls most pronounced in shallow sections.

Longitudinal section.—Axial tube intermittent because of contortions. Small and nearly parallel encircling zooecia commonly contain diaphragms at region of branching. Second circle of zooecia derived from first by budding from outer walls, diverging from axis at small angle, bent abruptly outward at about half length, inclined about 60 degrees at surface; diaphragms, one, rarely two, commonly absent. Zooecial walls quite thin axially, somewhat thicker midway to surface, very strong in mature region.

Comparison.—This species differs from *C. hispida* Ulrich in having 5 zooecia in 2 mm., rather than 8 or 9 in one-tenth inch

(2.54 mm.) *C. hispida* has 7 to 9 zooecia in the first circle surrounding the axial tube, whereas this species has about 11 such cells around a much larger axial tube. The zooecial walls in tangential section do not become laminar distally in this species, although there is some reduction in thickness.

Type.—Holotype, U. C. 47200; locality 23.

Genus MEEKOPORA Ulrich, 1890

MEEKOPORA ABRUPTA Easton, n. sp.

Plate 22, figures 5, 6

Zoarium unilamellar, 2 mm. to 6 mm. thick. Zooecia circular with slightly raised rims, 10 or 11 in 5 mm. Monticules about 2 mm. across, about 5 mm. between centers rising about 1.5 mm. above general surface. Epithea very thin. Vesicular tissue increasing in area of monticules where zooecia are slightly larger.

Tangential section.—Typical zoecium measures 0.30 mm. in width, walls of rather thick sclerenchymous nature, measure 0.40 mm. through. Lunarium obsolete. Vesicles rounded, generally in a single row separating adjacent zooecia, which are encircled by about 9 vesicles. Abnormally large zooecia apparently formed by fusion or coalescence of two normal zooecia. Vesicles in monticules smaller, less rounded, generally in two rows between adjacent zooecia.

Longitudinal section.—Lamella originating from zooecia of unilamellar type, expanding in opposite direction from original growth, forming pseudobifoliate frond. Zooecia with 4 or fewer unperforated occasionally slightly concave diaphragms about one and one-half tube diameters apart, located near origins of zooecia. Vesicles arranged as somewhat parallel crescentic lines 0.08 mm. high, about three times that width, generally covered with a thin sclerenchyme on upper surface. Zooecia originating parallel with epithea, quickly turning upwards and proceeding to surface at constant angle.

Comparison.—This species differs from *M. eximia* Ulrich in abrupt deflection of the zooecia from point of origin to surface, thicker zooecial walls, fewer diaphragms, larger zooecial apertures, and apparently a unilamellar structure.

Types.—Holotype, U. C. 48188; paratype, U. C. 48189; all from locality 15.

MEEKOPORA TENUIS Easton, n. sp.

Plate 22, figures 7, 8

Zoarium unilamellar, with zoarial characters similar to preceding species.

Tangential section.—Characters similar to preceding species, except that lunarium is better defined and vesicles within monticules are not numerous.

Longitudinal section.—Extremely thin diaphragms set at varying angles, and not restricted to the portions near origins of zooecia. Diaphragms may be slightly concave, about one tube diameter apart. Vesicles small, lack sclerenchymous layer except near surface of zoarium. Zooecia parallel surface of zoarium for only about one tube diameter, then turn to meet surface at about right angles.

Comparison.—This species differs from *M. abrupta*, n. sp., chiefly in the thinner diaphragms, which are set throughout the tubes at angles oblique to the zooecial walls. Also, this species has smaller vesicles with the sclerenchyme layer present only near the zoarial surface. It differs from *M. eximia* Ulrich in the same way as *M. abrupta*, n. sp. The latter species could be derived from *M. tenuis*, n. sp. by thickening of the diaphragms, increase in sclerenchyme within the vesicles, and more regular placement of the diaphragms.

Type.—Holotype, U. C. 48190; locality 7.

Suborder TREPOSTOMATA

Family BATOSTOMELLIDAE

Genus TABULIPORA Young, 1883

TABULIPORA CESTRIENSIS (Ulrich)

Remarks.—The Pitkin material makes it possible to add one important point to the

original description, namely, that the laminar portion of the zoarium merges into subcylindrical ramose portions of the zoarium 15 mm. to 20 mm. in greatest diameter.

Material.—Plesiotypes; U. C. 48183 from locality 7; 48184 from locality 17.

TABULIPORA MICROFISTULATA

Easton, n. sp.

Plate 22, figures 9, 10

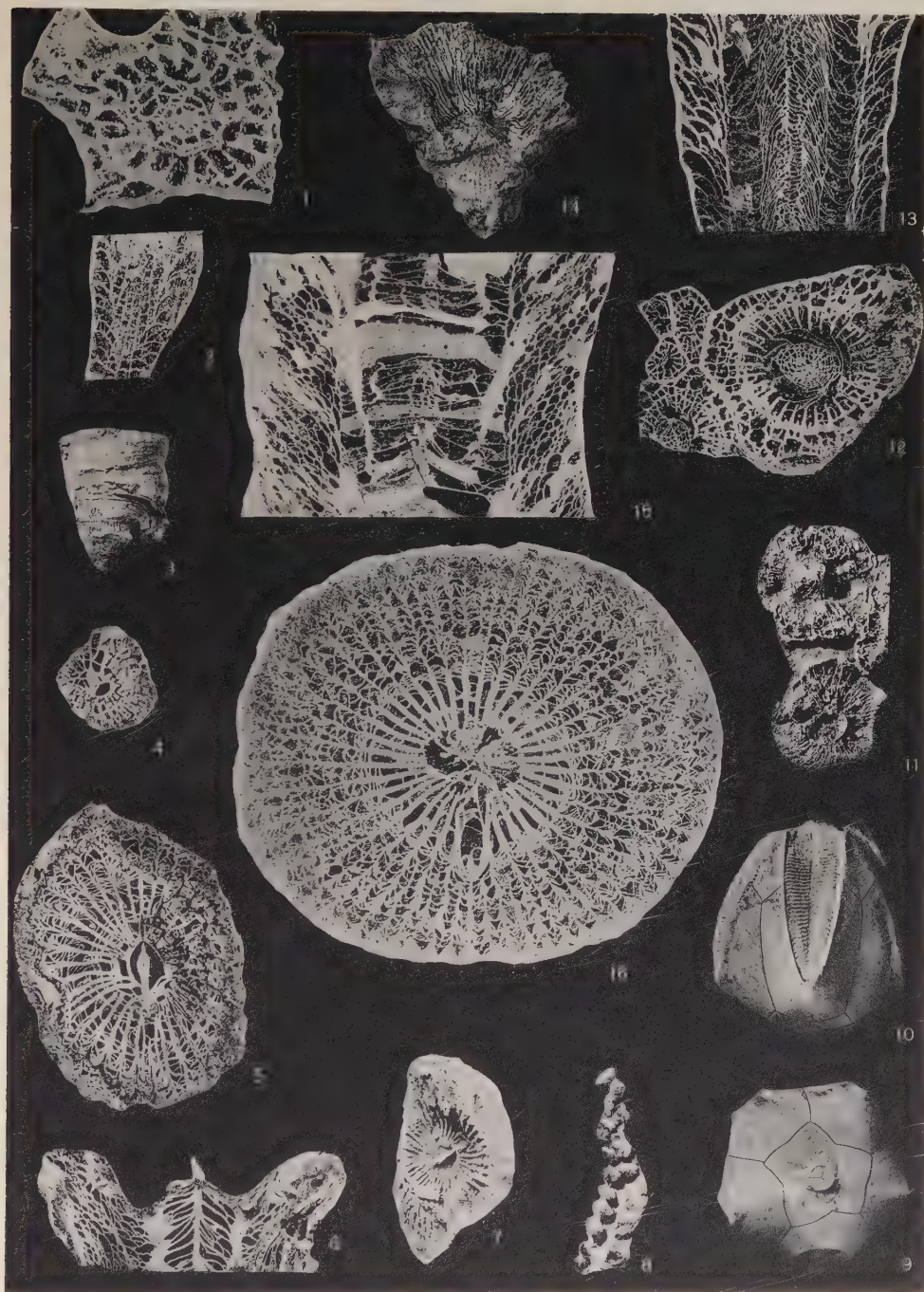
Zoarium laminar at basal expansion, rising to ramose stems 1.5 cm. to 2 cm. in diameter. Zoarium about 15 cm. in longest dimension, about 5 cm. wide and high. Surface details not visible.

Tangential section.—Zooecia subcircular, about 0.23 mm. in diameter, about 12 zooecia in 3 mm., combined width of thick adjacent walls 0.04 mm. to 0.08 mm. Acanthopores small, irregularly arranged, at angles or between angles of zooecia; in the latter case almost invariably protruding into one or both adjacent zooecia. Adjacent zooecial walls separated by more or less well defined dividing line showing fundamental polygonal shape of zooecia. Walls locally speckled with numerous, scattered, minute, dark spots. Mesopores fairly common, irregular in outline, usually less than half as wide as zooecia. Perforations in diaphragms large, about one-half the diameter of the diaphragms. Lunaria not observed.

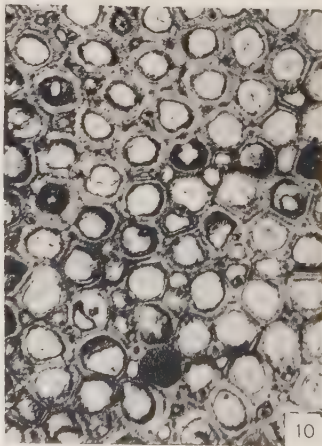
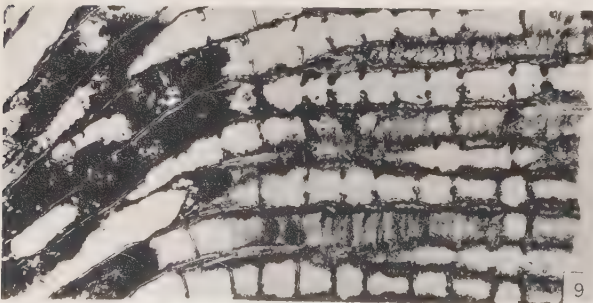
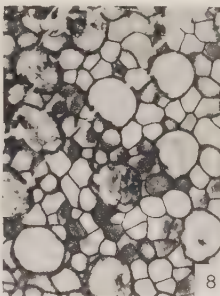
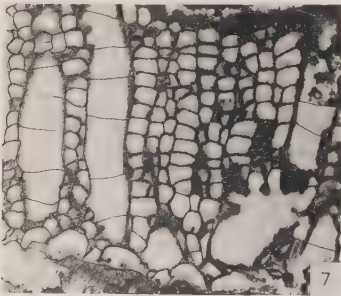
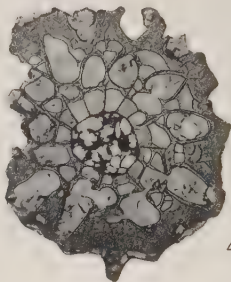
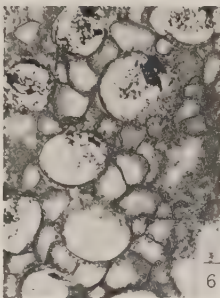
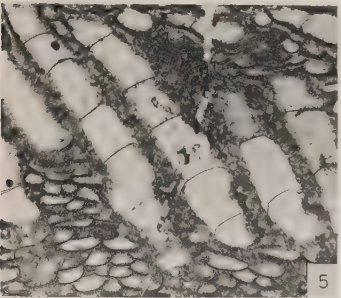
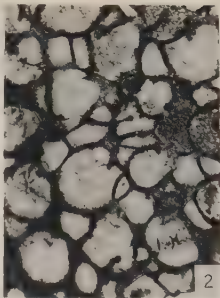
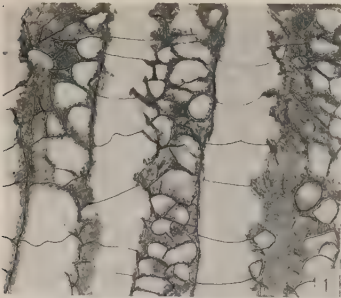
Longitudinal section.—Zooecia inclined about 45 degrees to axis of stem, straight in immature region, curving outward in mature region, becoming normal to surface. Walls very ragged, moniliform, swellings commonly coalesced throughout their extent; broadly wrinkled in immature region;

EXPLANATION OF PLATE 21

- FIGS. 1, 2—*Lonsdaleia minor*, n. sp. 1, transverse section, $\times 6$; 2, longitudinal section showing large dissepiments, $\times 6$; U. C. 48256, holotype. (p. 135)
 3–7—*Koninckophyllum talonatum*, s. sp. 3, corallite, $\times \frac{1}{2}$, U. C. 48259, ideotype. 4, early ephebic transverse section, $\times 2$; 5, late ephebic transverse section, $\times 2$; 6, longitudinal section, $\times 2$; 7, calyx, $\times 2$; U. C. 48257, holotype. (p. 129)
 8—*Schoenaster?* sp. Portion of an arm, $\times 4$; U. C. 48292. (p. 137)
 9, 10—*Pentremiles laminatus*, n. sp. 9, basal view, $\times 2$; 10, lateral view, $\times 2$; U. C. 48293, holotype. (p. 136)
 11–13—*Lonsdaleia major*, n. sp. 11, calices, $\times 1$; 12, transverse sections, $\times 2$; 13, longitudinal section, $\times 2$; U. C. 48261, holotype. (p. 135)
 14–16—*Caninostrotion variabilis*, n. gen., n. sp. 14, calyx, $\times 1$; U. C. 47203, paratype. 15, longitudinal section, $\times 2$; U. C. 48272, ideotype; 16, late ephebic transverse section, $\times 2$; U. C. 48367, holotype. (p. 134)



Easton, Pitkin Fauna



Easton, Pitkin Fauna

compactly wrinkled, much thicker in outer three-fourths of mature region. Diaphragms, perforated, 14 to 17, separated by one-half to one tube diameter in mature region, rims of perforations slightly thickened.

Comparison.—This species differs from *Tabulipora cestriensis* Ulrich chiefly in the large ramose (as well as laminar) zoaria, the more ragged zooecial walls, and the larger acanthopores. R. S. Bassler,³ who compared this specimen with the holotype of *T. meekana* Ulrich, which it resembles most closely, reports that

... the zooecia are thinner walled and of less diameter than in the type form.

Type.—Holotype, U. C. 48187; locality 8.

TABULIPORA POCULOFORMIS

Easton, n. sp.

Plate 23, figures 1, 2

Zoarium bilamellar, consisting of superimposed layers 0.9 to 1.1 mm. thick, rather than of opposed lamellae with mesotheca. Surface with low monticules, 4 mm. between centers, about 2 mm. in diameter. Polygonal zooecia thickwalled, 13 to 14 in 5 mm. Other surface details not preserved.

Tangential section.—Typical zooecium 0.3 mm. wide; maximum combined width of adjacent walls 0.04 mm. Acanthopores rather large, forming swellings at and between the angles of zooecia. Adjacent zooecial walls separated by thin dividing line. Mesopores subcircular, fairly abundant, diameters about one-fourth those of the zooecia. Strong, geniculate, hooklike processes extending from walls into some zooecia may be vestigial lunaria. Perforations in the diaphragms large, diameters about one-third those of zooecia.

Longitudinal section.—Zooecia arising from very thin contorted epitheca at angle of about 30 degrees, evenly curved, becoming normal to surface, resembling elongate drinking cups. Zooecial walls rather contorted, thickest near surface. Swellings in the mature portion of moniliform zooecial walls elongate, commonly ragged. Each zooecium commonly with 5 or exceptionally 7 or 8 perforated diaphragms, one-half tube diameter apart, with edges of perforations reflexed or swollen, forming prominent terminations of diaphragms at perforations. Superimposed laminae separated by two or three rows of vesicles, each about half as wide as zooecia.

Comparison.—This species differs from *T. rudis* Ulrich in the leaflike zoarium and the low monticules, and, according to R. S. Bassler,⁴ who kindly compared this species with the type of *T. rudis*,

... in the slightly smaller zooecia, with thinner walls, with the beading of the walls less developed and with the perforated diaphragms more crowded.

The holotype may possibly be the basal expansion of a zoarium.

Type.—Holotype, 48182; locality 8.

TABULIPORA REFLEXA

Easton, n. sp.

Plate 23, figures 3, 4

Zoarium ramose, rather regularly branched every 1.5 cm. to 2 cm., branches arising from encrusting conical base 2 cm. wide and 5 mm. high.

Tangential section.—Zooecial apertures subcircular, 0.2 mm. in diameter, 3 in space of 1 mm. Combined thickness of walls commonly about 0.1 mm., but may be twice as

³ Correspondence, April 29, 1940.

⁴ Correspondence, April 29, 1940.

EXPLANATION OF PLATE 22

- FIGS. 1, 2—*Fistulipora introspinosa*, n. sp. 1, longitudinal section, $\times 20$; 2, tangential section, $\times 20$; U. C. 48197, holotype. (p. 138)
 3, 4—*Chilotrypa regularis*, n. sp. 3, longitudinal section, $\times 20$; 4, transverse section, $\times 20$; U. C. 47200, holotype. (p. 139)
 5, 6—*Meekopora abrupta*, n. sp. 5, longitudinal section, $\times 20$; 6, tangential section, $\times 20$; U. C. 48188, holotype. (p. 139)
 7, 8—*Meekopora tenuis*, n. sp. 7, longitudinal section, $\times 20$; 8, tangential section, $\times 20$; U. C. 48190, holotype. (p. 140)
 9, 10—*Tabulipora microfistulata*, n. sp. 9, longitudinal section, $\times 20$; 10, tangential section, $\times 20$; U. C. 48187, holotype. (p. 140)

thick. Acanthopores large, with centrally located dark spots at most of interzooecial angles. As many as 4 similar dark spots commonly situated in line separating adjacent zooecial walls. Mesopores rare, about half as wide as zooecia.

Longitudinal section.—Tubes in axial region not moniliform, lacking diaphragms, rather straight walled, slightly inclined toward mature region, becoming crooked, sharply curved, meeting surface at right angles. Zooecia with 8 or 9 perforated diaphragms less than one tube diameter apart. Zooecial walls moniliform, some of adjacent swellings fused, exceedingly thick and ragged.

Comparison.—This species differs from *T. carbonaria* (Worthen) in the less massive branches, closer spacing of zooecial apertures, tubes bending more abruptly at the mature region, and much more moniliform walls. Weathering has obliterated details of the surface.

Type.—Holotype, U.C. 48191; from locality 20.

TABULIPORA SUBTILIS

Easton, n. sp.

Plate 23, figures 5, 6

Zoarium ramose, stems ovate in cross-section, diameters of the paratype 8 mm. and 5.5 mm. Monticules with slightly larger zooecial apertures, very low, 3 to 4 mm. between centers. Apertures polygonal but irregularly shaped, 21 or 22 in 5 mm.

Tangential section.—Zooecia very thick-walled, polygonal shape modified by sclerenchyme so that cross-sections are subcircular. Diameters of zooecia from 0.15 to 0.30 mm.; maximum combined width of adjacent walls 0.08 mm. which is about twice average thickness. Adjacent zooecial walls separated by strong dividing line. Acanthopores rather strong at or near angles, may extend short distance within zooecia. Dark spots on dividing line between acanthopores, minute, sparse. Mesopores fairly common, variable in size, averaging about one-third as wide as zooecia. Diameter of perforations in diaphragms about two-fifths zooecial diameter. No trace of lunaria observed.

Longitudinal section.—Walls of the zooecia broadly wrinkled in immature region. Zooecia curve away from axis of stem, great-

est curvature being at inner part of mature region. Zooecia thicker-walled in mature region, moniliform, commonly with one swelling between each set of diaphragms. Diaphragms 7 or 8, perforated with thickened rims, about one-half tube diameter apart.

Comparison.—This species differs from *T. ramosa* Ulrich in the presence of 2 or 3 more diaphragms in each zooecium, and, as reported by R. S. Bassler,⁵ who kindly compared this specimen with the holotype of *T. ramosa*, it is

... similar to the type specimen, but the zooecia are decidedly smaller, thinner walled and with less developed acanthopores.

Type.—Holotype, U.C. 48180; locality 7.

Suborder CRYPTOSTOMATA

Family FENESTELLIDAE

Genus ARCHIMEDIPORA d'Orbigny, 1850

Remarks.—The name *Archimedes* was first published by Owen (1842, p. 19), who described it as

... a very remarkable fossil coralline, resembling the *Retepora* of Lin., but verticillated spirally like a continuous screw; described by Lesueur under the appropriate name of *Archimedes*.*

Owen added in the indicated footnote,

I am not sure that Lesueur ever published his description of this fossil; ... he considered it, I believe, a new genus; but it may be only a new species of *Retepora*; if so, most aptly entitled *Retepora Archimedes*.

An accompanying sketch is entitled "Archimedes, of Lesueur."

In 1852 Owen figured another specimen as *Retepora Archimedes*, concerning which he stated (Owen, 1852, pl. IV, figs. 1, 1a, and explanation),

It has been known to Western geologists for many years under the name of *Archimedes*.

Regarding his 1842 paper, he went on to say that

... it seemed to be a species of *Retepora* coiled in the shape of a screw.

From the above, it is evident that *Archimedes*, as a genus, was not definitely proposed by Owen (nor by Owen for Lesueur) in

⁵ Correspondence, April 29, 1940.

1842, because he was not certain of Lesueur's intentions regarding it, as exemplified by Owen's statement "he considered it, I believe, a new genus; but it may be only a new species of *Retepora*." Furthermore, he definitely referred to it as *Retepora Archimedes* and his subsequent reference in the same paper to *Archimedes* must, therefore, be considered as a reference to the trivial name of *R. archimedes* Owen. Neither of these references constitutes a generic diagnosis, and the labeling of his figure of 1842 as "*Archimedes*, of Lesueur" does not establish a new genus according to the International Rules of Zoological Nomenclature, but Owen, by illustrating and naming *Retepora Archimedes*, definitely made a new species available under the rules.

In 1850, d'Orbigny (p. 102) erected the genus *Archimediopora* with the following diagnosis:

Cellules longues, placées aux angles saillants d'une spirale autour d'une tige allongée;

as the only species under *Archimediopora*, d'Orbigny indicated

Archimedes, d'Orb. *Retepora Archimedes*, Lesueur, 1842.

Here, then, is the definite naming of a new genus. D'Orbigny erred in referring the species *A. archimedes* to himself, as he quoted Owen for it. Lesueur's name is better omitted from synonymies because he did not publish his findings, nor did he furnish the published description; it is merely demonstrated that he also discovered the fossils and his *nomen nudum* was perpetuated. In 1847 Yandell and Shumard mentioned the occurrence of *Archimedes* [*sic*] in their "Contributions to the Geology of Kentucky" (p. 25), but gave no diagnosis, so this reference has no standing, either.

Hall (1856, p. 177) pointed out that d'Orbigny not only misunderstood the taxonomy and morphology of *Retepora Archimedes* Owen, but recorded it from the Devonian; therefore, Hall contended that *Archimediopora* is not valid. Hall correctly reported the facts, but his contention is not in accordance with the International Rules of Zoological Nomenclature.

The genotype of *Archimedes* was selected by Miller (1889, p. 292) as *Archimedes wor-*

theni Hall. *Archimedes wortheni* Hall is considered to be synonymous with *Retepora Archimedes* Owen = *Archimedes archimedes* (Owen) = *Archimediopora archimedes* (Owen). Owen's species clearly has priority, but the types are lost, in so far as the writer can determine, therefore, the writer designates as the neotypes of *Archimediopora archimedes* (Owen) the types of *Archimedes wortheni* Hall, which are in the American Museum of Natural History, type number 5058/1.

The types of the genotype species thus remain the same, but the genotype should be known as *Archimediopora archimedes* (Owen), which is the available name of the erstwhile *Archimedes wortheni* Hall.

Undesirable as it may be, the setting aside of *Archimedes* as a valid genus seems to be the only course to follow, if the rules are to be followed strictly. Should the International Commission on Zoological Nomenclature desire to make an exception in this case, then *Archimedes* may be validated, but until that time the author believes it is invalid.

Several species of *Archimediopora* from the Pitkin have the supports termed by Hall (1858, pp. 651, 652, pl. 22, fig. 3) "oblique braces," "props," and "braces." From Hall's description and figure, the oblique braces, as they may well be termed, are represented as occurring only between flanges of spiral supports. The specimens at hand have oblique braces extending away from the axis and passing through several fronds. Hall stated that the oblique braces are solid, whereas, at least some of the Pitkin specimens are hollow. The oblique braces must certainly have served as means of support, as they are located at the region where currents would develop the greatest stress upon the frond.

It is interesting that this genus also occurs in the Old World, as shown by Nikiforova (1938, p. 234), who points out that Stucken-berg discovered the genus in 1875 in the "Mountain Limestone" of Timan. Nikiforova states that the genus occupies a somewhat higher stratigraphic position in Russia than in North America, being abundant in the Upper and Middle Carboniferous of the U.S.S.R.

Material.—Oblique braces are shown on U. C. numbers 48347–48351, inclusive (see pl. 23, fig. 13).

Genus *LYROPORA* Hall, 1857
LYROPORA SOLIDA Easton, n. sp.
 Plate 23, figures 7, 8

Zoarium with apertures on concave side of frond. Base of support not preserved. Lateral supports thickened, forming periphery of zoarium which is reflexed in holotype to form deep horseshoe-shaped notch separating lateral lobes. Thickened periphery everywhere ornamented with lirations numerous, fine, anastomosing, irregularly directed, locally extending onto 2 or 3 fenestrules of frond. Zoarium of holotype incomplete, at least 5 cm. high, 8 cm. broad.

Zooecia 23 or 24 in 5 mm., in two slightly irregular ranges, except before origin of new branch, where 3 rows extend for about 5 zooecia. Apertures subcircular, 0.08 mm. in diameter, with a peristome. Branches originate by intercalation, possibly by lateral branching; no undoubted instance of bifurcation observed. Dissepiments about 0.29 mm. wide, 16 to 18 fenestrules in 1 cm. (measured across dissepiments). Branches about 0.21 mm. wide, 24 or 25 fenestrules in 1 cm. (measured across branches). Fenestrules suboval about 0.24 mm. wide, about 0.27 mm. long, arranged in diagonal rows. Branches and dissepiments much thickened, especially at junctions, forming low nodes on reverse side; branches and dissepiments both marked near reverse surface in thin sections by striae. Hemisepta strong, occurring in almost all zooecia, located well out on floor next to reverse side. Median keel on obverse surface nearly obsolete, line of sinuous, weak elongate nodes present. One to 3 pores 0.03 to 0.04 mm. in diameter are located irregularly near the obverse surface on dissepiments; similar pores are rarely located on branches between apertures.

Comparison.—This species combines certain characters of several Chester species but is most similar to *L. quincuncialis* Hall, from which it differs chiefly in having zooecia twice as closely spaced. It is similar to *L. ovalis* Ulrich in having the apertures on the concave surface, but differs in having more than 10 fenestrules in 1 cm. The species can be distinguished from *L. ranosculum* Ulrich and *L. subquadrans* Hall by its two ranges of apertures on the branches, rather than more. Though similar to *L. divergens* Ulrich in pos-

sessing peristomes, this species differs in having more than 12 or 13 fenestrules in 1 cm. Details of the obverse surface were observed from thin sections, as that surface is buried in the matrix of the specimens studied.

Types.—Holotype, U. C. 47201; paratype, U. C. 47204; both from locality 37.

Family CYSTODICTYONIDAE
 Genus *DICHOTRYPA* Ulrich, 1890
DICHOTRYPA LEVIS Easton, n. sp.
 Plate 23, figures 9, 10

Zoarium a broadly wrinkled bifoliate expansion 1 to 2 mm. thick. Dimensions and zoarial margin unknown. Surface marked by strong, solid, elongate maculae, depressed, or with rim of slightly raised zooecia. Maculae smooth, about 1.7 to 1.8 mm. long, about 0.8 mm. wide, centers separated 2 to 4 mm. measured across breadth, 4 to 5 mm. along length. Apertures usually irregularly spaced, locally occurring in diagonal rows, about 9 or 10 apertures in 3 mm. spaced about their own diameter apart.

Tangential section.—Zooecia compressed-oval, about 0.12 mm. wide, about 0.17 mm. long, arranged with greatest dimensions roughly parallel. Lunaria poorly preserved or degenerate, commonly with one termination forming short projection into zooecia. Interspaces granular in shallow sections with occasional vesicles faintly showing.

Longitudinal section.—Median lamina strong, rather straight, with a deposit of secondary material on both sides. Zooecia prostrate from origin to about one-third to one-half their length, then swinging abruptly toward surface; near surface recurved toward origin. Zooecial walls strongest near origins, later less well defined. Dissepiments one or possibly two, thin, may occur near abrupt change in direction of zooecia. Interspaces most vesicular near median lamina, with granular sclerenchyme distributed irregularly. Superior hemisepta, when preserved, moderately strong.

Comparison.—This species differs from *D. elegans* Ulrich in having more closely spaced irregularly arranged apertures and without either circular or substellate maculae. It differs from *D. flabellum* Rominger in having

no substellate maculae, more closely spaced apertures and smooth maculae.

Type.—Holotype, U.S.G.S. 5198 from locality 1388 blue.

Genus GLYPTOPORA Ulrich, 1888

GLYPTOPORA CRASSA Easton, n. sp.

Plate 23, figures 11, 12

Zoarium bifoliate expansions 1 to 2 mm. thick, forming cup-like structures by coalescence; generally leaf-like, broadly wrinkled. Surface marked by depressed maculae or "dimples," commonly widest near one end, arranged with long axes sub-parallel. Rows of about 6 slightly elevated zooecia line each side of the maculae, may form horse-shoe-shaped rows of about 13 zooecia almost encircling maculae. Maculae 2 to 3 mm. long, 1 to 1.5 mm. wide, irregularly spaced, about 5 mm. between centers in direction of long axes, somewhat closer in other direction. Zooecia reniform, in diagonal rows, 13 apertures in 5 mm.

Tangential section.—Zooecia rather thick-walled, 0.20 mm. in average diameter. Lunaria fairly distinct in shallow sections, showing as two small angular extensions of slight swelling always located on same side of zooecia. Vesicles small, irregular, generally in 2 or more rows between zooecia. Maculae appear as undifferentiated material.

Longitudinal section.—Zooecia prostrate upon mesotheca, turn up sharply, reach surface at nearly right angles. Hemisepta and diaphragms 1 or 2, near origins of some zooecia. Vesicles small, irregularly placed. Mesotheca thin, covered on both sides with sclerenchyme. Row of very large semicircular vesicles adjacent to mesotheca, contains 1 to 4 sharp-pointed extensions from mesothecal sclerenchyme. Many large vesicles thicken and strengthen region in angles between ramifications of zooecial expansions. Maculae formed of closely packed vesicles with one row of larger vesicles next to mesotheca.

Comparison.—This species differs from *G. keyserlingi* Prout in having thicker fronds, smaller and unstriated maculae, and slightly larger zooecial apertures.

Types.—Holotype, U. C. 48199; paratype, U. C. 48200; both from locality 6.

Class BRACHIOPODA

Subclass INARTICULATA

Order NEOTREMATA

Family CRANIIDAE

Genus CRANIA Retzius, 1781

CRANIA INFIMBRIATA Easton, n. sp.

Plate 24, figure 11

Shell subcircular, length of holotype 1.3 cm. Most specimens measure about 1 cm. across.

Pedicle valve attached, also possibly free. Interior not observed.

Brachial valve, commonly very low, conical or almost flat, may be convex in seemingly unattached specimens. Apex eccentrically located, either depressed or acutely erect. Margin of valve overlaps pedicle valve, outline lobate in some specimens. Greatest depth of holotype about 2 mm. at apex. In specimen attached to exterior of a *Spirifer*, shell assumes general contour of latter, but its costae are not reflected. Surfaces of some specimens bear irregular, usually rugose, concentric growth marks most commonly near margin. Interior of one valve exposed, but not preserved sufficiently well to permit description of muscle scars.

Comparison.—This species is variable but can be distinguished readily from the only other described Chester species, *Crania chesterensis* Miller and Gurley, by the absence of the pronounced thickened marginal lip of the brachial valve. It differs from other species of *Crania* either in the absence of radiating costae or in the presence of coarse concentric markings.

Types.—Holotype, U.S.G.S. 5199; paratypes, U.S.G.S. 5200; all from locality 1388 blue.

Subclass ARTICULATA

Order PROTREMATA

Family STROPHOMENIDAE

Genus ORTHOTETES Fischer, 1830

ORTHOTETES SUSPECTUM (Girty)

Streptorhynchus suspectum GIRTY, 1929, Jour. Washington Acad. Sci., vol. 19, no. 7, p. 136, figs. 12–15.

Remarks.—The presence of a well-defined median septum in the pedicle valve of this species reveals, that it is an *Orthotetes*. There is evidence that Girty discovered this fact subsequent to his original description.

ORTHOTETES KASKASKIENSIS

McChesney var.

Orthotetes kaskaskiensis WELLER, 1914, Illinois Geol. Survey, Monograph 1, p. 77, pl. 6, fig. 15.

Remarks.—Stuart Weller figured a specimen of *Orthotetes kaskaskiensis* which differs from the typical specimens in that there are 4 fine costae between larger costae. A fragment of such a shell is in the Pitkin collections and compares precisely with the specimen Weller figured in every feature except size. It may be that this is a consistent variation, or perhaps it is merely an environmental variation. In modern oceans, shells of the pelecypod *Pecten* become coarsely ribbed when the animal lives in agitated water, whereas the same species may be smooth or nearly so in quieter water. Here then, may be an index to the ecology of the sea in which this species lived, for the specimen from the Pitkin came from a shaly limestone, rather than the dominant limestone phase. Other Pitkin specimens of the same species collected from the pure limestone strata have costae of equal strength.

Material.—U.C. 48329; locality 25.

Family PRODUCTIDAE

Genus CHONETES Fischer, 1837

CHONETES TUMESCENS Easton, n. sp.

Plate 24, figures 1–5

Shell concavo-convex to biconvex, curvature quite variable, length about two-thirds width, greatest width midway between cardinal area and anterior margin. Cardinal extremities angular, only slightly concave in front of cardinal extremities, rather evenly convex curvature continuing around anterior margin, although somewhat straightened in some specimens. Median sinus obsolete.

Pedicle valve flatly convex, greatest convexity just posterior to middle, surface curving abruptly anterior to middle, sloping flatly from beak to cardinal extremities. Beak minute, definitely extended beyond cardinal margin, marked by two short fine costae. Cardinal area flat, straight, longitudinally striated, tilted outwards somewhat, forming angle of about 100 degrees with surface of valve. Eight (in some cases, 7) hollow spines directed outwardly and laterally from each side of beak. Edges of delthyrium form angle of about 90 degrees; deltidium outwardly produced hood-like structure. Inner surface valve finely papillose bordering muscle scars, marginally more coarsely marked; short median septum separates muscle scars.

Brachial valve moderately concave to slightly convex, sloping to cardinal extremities. Cardinal area flat, longitudinally striated, about as wide as that of opposite valve, the two forming an angle of about 170 degrees. Cardinal process nearly filling delthyrium of opposite valve, bearing 6, coarse, radially arranged costae, median pair strongest. Cardinal process surmounted ventrally by 2 squat lobes, anteriorly by 2 very small swellings; very heavy rounded ridge extends laterally from each side of the cardinal process about one and one-half times width of cardinal process, forms angle of about 30 degrees with margin of cardinal area. Pair of delicate ridges with ventral extremities directed medianly diverge anteriorly from cardinal process at angle of about 55 degrees extend distance equal to width of cardinal process. Low median ridge extends directly anteriorly 3 times width of cardinal process. Interior of the valve finely papillose, except at muscle scars where it is smooth.

DIMENSIONS OF CHONETES TUMESCENS

	Length of valves		Width of valves		Greatest Width	Convexity
	Brachial	Pedicle	Brachial	Pedicle		
Holotype	11.0 mm.	11.2 mm.	13.9 mm.	14.2 mm.	15.1 mm.	2.4 mm.
Paratype 1	12.4	12.7	15.0	15.6	16.9	—
Paratype 2	11.3	11.6	16.0	16.2	17.8	2.2
Paratype 3	10.9	11.1	—	—	15.0	2.1
Paratype 4	11.5	12.3	15.9	16.3	16.6	2.2

Surfaces of both valves marked by fine radiating lirae developed either by bifurcation or intercalation, about 150 around margin of shell, 5 to 8 in 1 mm., finest posteriorly, wider than intervening furrows, absent only in long narrow triangular region on each side of beak and bordering cardinal area. Concentric growth lines well developed. Pits between lirae and growth lines about 4 in 1 mm., more or less regularly arranged.

Comparison.—This species is closely allied to *Chonetes chesterensis* Weller, but differs in having a less concave brachial valve, more spines on each side of beak, cardinal areas of about the same width on each valve, and it commonly attains larger size. It differs from *C. oklahomensis* Snider in having flatly sloping rather than recurved auricular extremities, a less concave brachial valve and a straight cardinal area that is flat rather than arcuate.

Types.—Holotype, U.C. 48296; paratype, U.C. 48297; both from locality 30.

Genus ECHINOCONCHUS Weller, 1914
ECHINOCONCHUS ? sp.

Remarks.—A small productid of unusual nature is tentatively referred to this genus at the suggestion of A. H. Sutton. The width of the shell is three-quarters the greatest length and the convexity is about half the greatest length. Concentric markings are restricted to the anterior portion of the shell and each band has more than one row of spinules. Although these characters are typical of *Echinoconchus*, the bands do not begin near the beak, the proportions of the shell are different, and the beak is more recurved than in that genus.

Material.—U.C. 48254; locality 25.

Genus KROTOVIA Fredericks, 1928
KROTOVIA LUCERNA Easton, n. sp.
Plate 24, figures 6–8

Shell broadly convex, flattened umbonally, evenly sloping to anterior margin, very steeply sloping to ears. Beak sharply rounded, recurved, extending 3 mm. beyond hinge line. Two specimens measure: lengths, 15.5 mm. and 12.5 mm.; widths, 14.3 mm. and 14.0 mm.; convexities, 6.5 mm. and 6.5

mm.; lengths of hinges, 12.0 mm. (restored) and 9.3 mm.

Pedicle valve of holotype small, sub-hemispherical, about as long as wide, one-fourth as high as long. Hinge line about three-quarters length of shell. Ears small, recurved ventrally, marked off by a sharp sulcus on each lateral slope. Cardinal extremities slightly anteriorly directed, rounded. Lateral margins evenly curved, not separated from anterior margin by differences in radii of curvatures except near hinge line where curvature is more abrupt. Highest point of curvature of ventral surface of shell just anterior of midlength. Median sinus faint or absent. Interior not seen.

Brachial valve not definitely identified.

Surface ornamented by numerous fine, subequal spinules reflexed upon surface, covering entire valve, somewhat finer on beak than elsewhere. On anterior slope spinules somewhat longitudinally arranged. Varices of growth few, irregularly spaced closest on lateral slopes and ears.

Comparison.—This species differs from *K. meeki* Dunbar and Condra in the smaller size, more pointed and narrower umbonal area, and more elongate spinules. It differs from *Pustula echinata* Moore in the larger spinules, more elongate umbo, and lower convexity.

Types.—Holotype, U.C. 48253 from locality 29; ideotype U.C. 48255 from locality 15; ideotype U.C. 48342 from locality 42.

Remarks.—According to A. H. Sutton⁶ *P. echinata* should be referred to *Krotovia*. If so, *K. lucerna* is the second species of the genus reported from the Mississippian of this country, and the third from our Carboniferous.

Genus PRODUCTUS Sowerby, 1812
PRODUCTUS CESTRIENSIS Worthen

Productus elegans NORWOOD AND PRATTEN, 1855, Acad. Nat. Sci. Philadelphia, Jour. Ser. 2, vol. 3, p. 3, pl. 1, figs. 7a–c. Not *Productus elegans* McCoy, 1844.

Productus cestriensis WORTHEN, 1860, St. Louis Acad. Sci., Trans., vol. 1, pp. 570, 571.

Productus elegans, SUTTON, 1938, Jour. Paleontology, vol. 12, no. 6, pp. 599, 567, pl. 64, figs. 9–12.

Remarks.—The above selected synonymy lists the first reference to the species, the

⁶ Correspondence, April 15, 1940.

reference to the available name, and the latest reference (which contains a long synonymy). Worthen found *Productus elegans* Norwood and Pratten to be a homonym of *Producta elegans* M'Coy, 1844, ("*Leptaena elegans*" on plate), and selected the name *P. cestrionensis* to replace it. Most subsequent workers have disregarded Worthen's action, as well as Articles 35 and 36 of the International Rules of Zoological Nomenclature. The fact that the species was once referred to *Diaphragmus* has no bearing on the case.

Genus LINOPRODUCTUS Chao, 1927

LINOPRODUCTUS PILEIFORMIS (McChesney)

Productus ovatus HALL, 1858, Geol. Iowa, vol. 1, pt. 2, p. 674, pl. 24, fig. 1. Not *Productus ovatus* PANDER 1830.

Productus pileiformis MCCHESENEY, 1859, Descriptions New Paleozoic Fossils, p. 40.

Linoproductus ovatus, SUTTON, 1938, Jour. Paleontology, vol. 12, no. 6, p. 558, pl. 65, figs. 8-13.

Remarks.—This case of a rejected homonym is similar to the last, the name being preoccupied by *P. ovatus* of Pander (1830, p. 86, pl. 27, figs. 13a, b). It is noted in an unfinished manuscript by G. H. Girty.

Order TELOTREMATA

Family SPIRIFERIDAE

Genus SYRINGOTHYRIS Winchell, 1863

SYRINGOTHYRIS AEQUALIS Easton, n. sp.

Plate 24, figures 12-14

Shell large, half again as wide as long, greatest width of brachial valve between cardinal extremities 5 cm. in one specimen, greatest length medially 2.7 cm. Length of

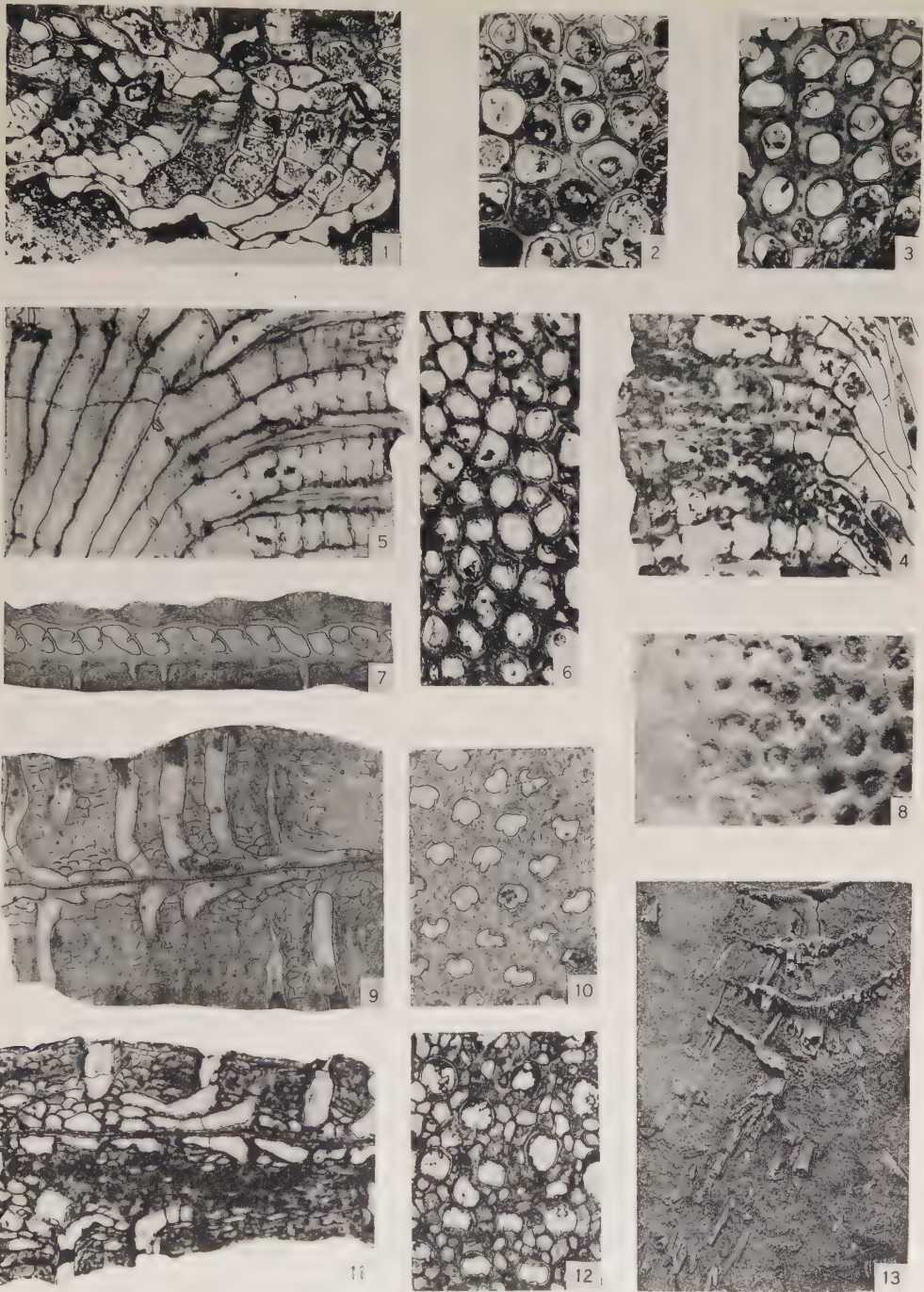
pedicle valve of holotype 23 mm. from beak to anterior margin; height of cardinal area 17.5 mm.; width of cardinal area 38 mm.; width of delthyrium at base 12 mm.; width of anterior portion of sinus about 10 or 11 mm.

Pedicle valve sharply pyramidal, anterior slope somewhat convex near beak but nearly straight for last three-quarters of length; lateral slopes slightly concave from umbo to cardinal extremities. Median sinus broad, shallow, without plications, originating as sharp depression at beak, extending about 2.5 mm. beyond anterior margins of sides. Cardinal area very high, inclined almost 90 degrees to the plane of valves, marked by broad but strong concentric markings parallel to hinge line; depth of curvature along lateral slopes about 1 mm. in 25 mm. Beak slightly produced posteriorly. Lateral margins 12 or 13 mm. wide at hinge line. Delthyrium two-thirds as wide as high; delthyrial plate depressed 1.5 to 2 mm. below cardinal area, bordered by groove extending full length of the delthyrium; delthyrial plate sharply concave on each side of very strong external median rib which extends nearly 9 mm. down from beak. Dental lamellae not observed.

Brachial valve with broad, low, uniplicate fold originating at recurved beak; fold highest at anterior end, producing emargination. Greatest depth of valve posterior to mid-length. Greatest convexity along median portion near hinge line, flatter toward cardinal extremities. Angle between hinge line and lateral margins nearly 90 degrees. Muscle scars divided by median septum showing

EXPLANATION OF PLATE 23

- FIGS. 1, 2—*Tabulipora poculoformis*, n. sp. 1, longitudinal section, $\times 20$; 2, tangential section, $\times 20$; U. C. 48182, holotype. (p. 141)
 3, 4—*Tabulipora reflexa*, n. sp. 3, tangential section, $\times 20$; 4, longitudinal section, $\times 20$; U. C. 48191, holotype. (p. 141)
 5, 6—*Tabulipora subtilis*, n. sp. 5, longitudinal section, $\times 20$; 6, tangential section, $\times 20$; U. C. 48180, holotype. (p. 142)
 7, 8—*Lyropora solida*, n. sp. 7, vertical section through one side of branch, showing hemisepta, $\times 20$; U. C. 47201, holotype. 8, reverse side of part of frond showing minute wrinkles on solid border, $\times 10$; U. C. 47204, paratype. (p. 144)
 9, 10—*Dichotrypa levis*, n. sp. 9, longitudinal section, $\times 20$; 10, shallow tangential section showing dense sclerenchyme, $\times 20$; U.S.G.S. 5198, holotype. (p. 144)
 11, 12—*Glyptopora crassa*, n. sp. 11, longitudinal section, $\times 20$; 12, tangential section, $\times 20$; U. C. 48199, holotype. (p. 145)
 13—*Archimediopora* sp., showing oblique braces, $\times 1$; U. C. 48347. (p. 143)



Easton, Pitkin Fauna



Easton, Pitkin Fauna

through shell substance for two-thirds of length of valve.

Surface of pedicle valve with 21 to 23 unbranching plications on lateral slopes; plications increasingly rugged anteriorly, parallel to sinus, laterally inclined, becoming nearly parallel to cardinal margin; stronger plications originate near beak, progressively weaker plications originate along cardinal margins. Broad concentric markings present. Lateral margins plicate on brachial as on pedicle valve, but concentric markings somewhat stronger.

The pedicle valve of a very young specimen shows quite rounded cardinal margins, a slightly concave cardinal area, an incurved beak, a well developed slightly produced sinus with re-entrant angles on each side at the junction with the lateral margins, 10 plications, and rounded lateral cardinal areas. This valve is 8.5 mm. wide, 5 mm. long, and the cardinal area is 3.7 mm. high.

Comparison.—This species can be distinguished from *S. hannibalensis* (Swallow) by the shallower and less produced sinus. It differs from *S. newarkensis* Weller by the width of each cardinal margin being nearly equal to the width of the delthyrium. In one large crushed specimen the height of the cardinal area is 30 mm. and the greatest width of the delthyrium is 20 mm.

Types.—Holotype, U.S.G.S. 5201; para-

types, U.S.G.S. 5202; all from locality 1379 blue.

Phylum MOLLUSCA

Class PECECYPODA

Order PRIONODESMACEA

Family AVICULOPECTINIDAE

Genus AVICULOPECTEN McCoy,

1851, emend. Newell, 1937

AVICULOPECTEN BATESVILLENSIS

Weller

Aviculopecten batesvillensis WELLER, 1897, Trans., New York Acad. Sci., vol. 16, p. 263, pl. 19, figs. 3, 4.

Aviculopecten batesvillensis, WELLER, 1898, U. S. Geol. Surv. Bull., 153, p. 107.

Deltopecten batesvillensis, GIRTY, 1911, U. S. Geol. Surv., Bull. 439, p. 89, pl. 11, figs. 1-4

Deltopecten batesvillensis, SNIDER, 1915, Oklahoma Geol. Survey, Bull. 24, pp. 42, 108, chart facing p. 66.

Deltopecten batesvillensis?, GIRTY in REGER, 1926, West Virginia Geol. Survey, p. 853.

Deltopecten batesvillensis, ROTH, 1929, Oklahoma Geol. Survey, Circ. 18, chart facing p. 16.

Deltopecten batesvillensis, CRONEIS, 1930, Arkansas Geol. Survey, Bull. 3, pp. 54, 55, 62-64, 71, 75, pl. 13, fig. 20, pl. 15, fig. 13.

Deltopecten batesvillensis, MORSE, 1930, Mississippi Geol. Survey, Bull. 23, pp. 170, 184.

Remarks.—Newell (1937, p. 64) has shown that the characters separating *Deltopecten* from *Aviculopecten* do not exist in most Carboniferous forms, and that the former genus is confined to the Middle and Upper

EXPLANATION OF PLATE 24

- FIGS. 1-5—*Chonetes tumescens*, n. sp. 1, exterior of pedicle valve, $\times 2$; 2, interior of pedicle valve, $\times 2$; 3, interior of brachial valve, $\times 2$; 4, exterior of brachial valve, $\times 2$. 5, posterior view of shell, $\times 2$. Figs. 1, 4, 5, U. C. 48296, holotype; figs. 2, 3, U. C. 48297, paratype. (p. 146)
- 6-8—*Krotavia lucerna*, n. sp. 6, lateral view of pedicle valve, $\times 2$; U. C. 48342, ideotype; 7, posterior view of pedicle valve, $\times 2$; 8, dorsal view of pedicle valve, $\times 2$; U. C. 48253, holotype. (p. 147)
- 9, 10—*Aganaster cingulatus*, n. sp. 9, dorsal view, $\times 6$, paratype; 10, ventral view, $\times 6$, holotype; all on one slab, U. C. 48291. (p. 137)
- 11—*Crania infimbriata*, n. sp. Brachial valve, $\times 2$; U. S. G. S. 5199, holotype. (p. 145)
- 12-14—*Syringothyris aequalis*, n. sp. 12, posterior view of pedicle valve, $\times 1$; 13, anterior view of pedicle valve, $\times 1$; U.S.G.S. 5201, holotype. 14, ventral view of brachial valve, $\times 1$; U.S.G.S. 5202, paratype. (p. 148)
- 15—*Paladin mucronatus* (Girty). Carapace, $\times 1$, U. C. 48313. (p. 152)
- 16—*Eoastanites globosus*, n. sp. Adoral view, $\times 2$, U. C. 48192, holotype. (p. 152)
- 17-19—*Mourlonia angulata*, n. sp. 17, apical view, $\times 5$; 18, lateral view, $\times 5$; U.S.G.S. 5203, holotype. 19, lateral view of part of two whorls showing color markings, $\times 5$; U.S.G.S. 5204, paratype. (p. 150)
- 20, 21—*Straparolus triliris*, n. sp. 20, apical view, $\times 2$; 21, lateral view, $\times 2$; U. C. 48304, holotype. (p. 151)
- 22—*Euphemites incarinatus*, n. sp. Lateral view, $\times 2$; U. C. 48325, holotype. (p. 150)
- 23—*Helcionopsis? reticulatus*, n. sp. Exterior, $\times 1$; U. C. 47202, holotype. (p. 150)

Permian of the Eastern Hemisphere. This species must, therefore, be returned to its original genus.

Class GASTROPODA

Subclass STREPTONEURA

Order ASPIDOBANCHIA

Suborder DOCGLOSSA

Family PALAEACMAEIDAE

Genus HELCIONOPSIS Ulrich and

Scofield, 1897

HELCIONOPSIS? RETICULATUS Easton, n. sp.

Plate 24, figure 23

Shell subcircular, patelliform, anterior end truncated slightly obliquely to greatest (anterior-posterior) diameter. Shell broken away from beak of monotype, but internal cast approximately determines shell margin at produced beak. Beak located to one side of center line. Surface ornamented by two sets of obliquely intersecting markings forming reticulated pattern; numerous closely spaced fine costae near center line have coarser counterparts more widely spaced on lateral slope toward which beak is deflected (coarser markings may have counterparts on other slope, but they are not apparent). Second set of markings, nearly equally spaced, subparallel, intersect the costae obliquely, cross shell from anterior-lateral margin to opposite or posteriolateral margin toward which beak is deflected. Internal structure unknown. Dimensions: greatest length 26 mm., greatest breadth, 24 mm., greatest depth midway posteriorly from beak 7.5 mm.

Comparison.—The unique sculpturing alone is sufficient to differentiate this species from described species of either *Helcionopsis* or *Triblidium*. Although this species may represent a new genus, the nature of the muscle scars cannot be determined from the material at hand.

Type.—Holotype, U.C. 47202; locality 37.

Family BELLEROPHONTIDAE

Genus EUPHEMITES Warthin, 1930

EUPHEMITES INCARNATUS

Easton, n. sp.

Plate 24, figure 22

Shell small, involute, discoidal to subglobose in ephebic stages; dimensions of two

specimens greatest diameters, 8.2 mm. and 4.9 mm.; greatest widths of body whorls, 8.9 mm. and 5.2 mm. Aperture reniform, width twice length (in the plane of coiling). No prominent geniculation present in shell curvature. Body whorl recurved near umbilical regions, somewhat flared, not revolving. Whorl section acutely lunate posteriorly from aperture. Inner lip seemingly formed by surface of preceding whorl in most cases, without callosity; rare instances of seeming callosities may be result of mineralization. Umbilical regions not excavated, partly enclosed by recurved lateral extremities of body whorl. Surface finely but sharply lirate, about 40 principal lirae with much finer intercalated lirae near edge of aperture; faint transverse growth lines intersect lirae, effect reticulate pattern with concave interstices; fine details most pronounced on the body whorl, which is commonly broken away. About 30 lirations, strongest near plane of coiling, comprise ornamentation of next-to-last whorl. No slit observed, shell not carinate where the slit-band should be located.

Comparisons.—This species differs from *E. nodocarinatus* (Hall) and *E. inspeciosus* (White) in the smaller size, more discoidal shape, noncarinate volutions, nearly centrally located umbilicus, and deeply-impressed lunate whorl-section. There is considerable variation in shell shapes, but these comprise a series, rather than different species.

Types.—Holotype, U.C. 48325; paratypes, U.C. 48326; all from locality 35.

Suborder RHIPIDOGLOSSA

Family PLEUROTOMARIIDAE

Genus MOURLONIA Koninck, 1883

MOURLONIA ANGULATA Easton, n. sp.

Plate 24, figures 17-19

Shell small, turbiniform; spire straight-sided. Whorl profile above selenizone broadly convex. Selenizone slightly concave bounded by costae. Whorl profile below selenizone very sharply rounded above, broadly convex below, rather sharply rounded at umbilical shoulders. Nucleus apparently unornamented. Surface covered with well-defined oblique costae, about 8 in 1.0 mm., above selenizone slightly convex forward, below selenizone passing backward less obliquely,

swinging forward slightly to umbilical shoulders where reversal begins; thus, costae external to umbilical shoulder and below selenizone are convex backward but at smaller angle than above. Lunulae not clearly observed. Very fine revolving lirae present between selenizone and umbilical shoulders. Exceptionally, even finer lirae are preserved between selenizone and suture. Dark zig-zag color markings between suture and selenizone, directed backward more obliquely than costae, possess 2 sharply V-shaped backward angles in middle; repeated about every third or fourth costa; at periphery of whorl pass into irregular splotches.

	A	B
Number of whorls	4.5	4
Height	4.0	2.6
Width	4.8	3.2
Ratio of height to width	.83	.81
Ratio of height of body whorl to total height	1.82	1.86
Pleural angle	68°	71°

Comparison.—This species differs from *M. minuta* Weller chiefly in having a generally angular, rather than a rounded whorl profile, and in having ornamentation upon the portion of the whorl between the suture and selenizone.

Types.—Holotype, U.S.G.S. 5203, locality 1388 blue; paratype, U.S.G.S. 5204, locality 1388 blue; ideotypes, U.S.G.S. 5205, locality 1389 blue.

Remarks.—The holotype (A above) is nearly anomphalous, therefore, is about mature, as Knight (1941, p. 201) has pointed out that the members of this genus are phaneromphalous in the young stages but become anomphalous at the beginning of the mature stage. The measured paratype (B above) is juvenile, whereas, the two other paratypes, though mature, are incomplete.

Family EUOMPHALIDAE

Genus STRAPAROLUS Montfort, 1810

STRAPAROLUS TRILIRIS Easton, n. sp.

Plate 24, figures 20, 21

Shell subturinate, portion of apex including only nucleus depressed, four and one-half whorls present. Greatest diameter, 12.5 mm.; height, 7 mm.; width of aperture, 3.3 mm.; height, 4.0 mm. Nucleus rounded, unornamented; later whorls angular at upper

shoulder, slightly nodose at aperture. Upper portion of body whorl flattened from suture to shoulder; lateral slope almost vertical, concave band present just below angulation of shoulder, whorl expanding laterally below; under surface of whorl evenly rounded. Umbilicus broad, probably steep-walled and deep, partially filled in holotype. Surface ornamented chiefly by transverse axial lirae, very slightly inclined posteriorly on body whorl; on spire less well defined, nearly transverse. Three ill-defined revolving ridges present on upper surface of body whorl within 2 mm. of aperture, apparently terminating in nodes.

Comparison.—This species differs from *S. umbilicatus* (Meek and Worthen) in the less depressed spire, the flatness of upper surface of lower whorls which extends farther laterally, and the vertical slopes of the whorls. It can be distinguished from many species of *Straparolus* by its turbinate form.

Type.—Holotype, U.C. 40304; locality 5.

Class CEPHALOPODA

Order NAUTILOIDEA

Suborder CYRTOCHOANITES

Genus DOLORTHOCERAS Miller, 1931

DOLORTHOCERAS ? EUREKENSIS (Walcott)

Orthoceras eurekaensis WALCOTT, 1884, U. S. Geol. Survey, Mon. 8, p. 265, pl. 23, figs. 2, 2a. *Orthoceras eurekaensis?*, WELLER, 1897, Trans., New York Acad. Sci., vol. 16, p. 270, pl. 20, figs. 3, 3a.

Orthoceras eurekaensis, WELLER, 1898, U. S. Geol. Survey, Bull. 153, p. 395.

Orthoceras eurekaensis, SNIDER, 1915, Oklahoma Geol. Survey, Bull. 24, pp. 34, 39, 43, 118, 119, chart opp. p. 66.

Orthoceras eurekaensis, ROTH, 1929, Oklahoma Geol. Survey, Circ. 18, chart facing p. 16.

Orthoceras eurekaensis, CRONEIS, 1930, Arkansas Geol. Survey, Bull. 3, pp. 64, 76.

Remarks.—The orthoceraconic cephalopods from the Pitkin are provisionally placed in *Dolorthoceras*, except for those with the annulations characteristic of *Cycloceras*, and for one representative of *Mooreoceras* identified by Moore (1940, p. 415).

Suborder ORTHOCHOANITES

Genus COLOCERAS Hyatt, 1893

COLOCERAS sp.

Remarks.—Snider referred two specimens to *Leuroceras*, which, together with an addi-

tional specimen, the writer is referring to *Coloceras* sp. at the suggestion of A. K. Miller.⁷ *Leuroceras* can be distinguished from *Coloceras* by the sinuous sutures in the former genus and the nearly straight sutures in the latter.

Order AMMONOIDEA

Suborder EXTRASIPHONATA

Genus *EOASIANITES* Ružencev, 1933

EOASIANITES GLOBOSUS Easton, n. sp.

Plate 24, figure 16

Conch subglobular, maximum diameter of phragmacone at least 18 mm.; height of last whorl 7.8 mm.; width of umbilicus about 8 mm.; width of last whorl about 20 mm.; impressed zone 2.8 mm. deep. Whorls rather depressed dorsoventrally, ventral surface evenly rounded, nearly hemispherical in cross section. Umbilical slopes sharply rounded, diameter of umbilicus slightly less than half the greatest dimension of phragmacone. In reniform aperture is small central sinus, small lateral crest, another small sinus, finally large crest at umbilical slope. Shape of aperture cannot be determined in detail because of lack of growth lines.



FIG. 1—Diagrammatic representation of a suture of *Eoasianites globosus*, n. sp., $\times 3.5$.

Test thin, unornamented. Internal mold exhibits shallow concave constrictions directed medianly and anteriorly, strong lateral portions of which would meet at angle of 120 degrees if extended across obsolete median portion of constriction; probably fewer than 3 constrictions in one volution.

Sutures shown on holotype nearly identical, except for size. Each suture possesses short, sharply bifid, median saddle within more prominently bifid ventral lobe; first lateral saddle broadly spatulate; first lateral

lobe asymmetrically lanceolate, curving up least broadly on lateral side; second lateral saddle broadly curved but depressed just lateral to summit, curving sharply over umbilical slope; second lateral internal saddle flattened, broad; first lateral internal lobe elongate, swollen laterally about midway but sharply acuminate at termination; other sutural characters not shown. Second lateral external saddle broadest, first lateral lobes narrowest (except for bifurcations of external lobe), subequal.

Comparison.—This species is closely allied to *E. oblatius* (Miller and Moore) from the Morrow group, but differs in its somewhat smaller size, more globular shape, more rounded surface of whorls, V-shaped transverse constrictions, and minor differences in sutural expression.

Type.—Holotype, U.C. 48192; locality 16.

Phylum ARTHROPODA

Class CRUSTACEA

Subclass TRILOBITA

Order OPISTHOPARIA

Family PROETIDAE

Genus *PALADIN* Weller, 1936

PALADIN MUCRONATUS (Girty)

Plate 24, figure 15

- Griffithides mucronatus* Girty, 1910, Ann., New York Acad. Sci., vol. 20, no. 3, pt. 2, p. 238.
Griffithides mucronatus, Girty, 1915, U. S. Geol. Survey Bull. 593, pp. 14, 133, 134.
Griffithides mucronatus, Purdue and Miser, 1916, U. S. Geol. Survey, Folio 202, pp. 12, 13.
Griffithides mucronatus, Roth, 1929, Oklahoma. Geol. Survey, Circ. 18, chart facing p. 16.
Griffithides mucronatus, Croneis, 1930, Arkansas Geol. Survey, Bull. 3, pp. 63, 65, 71, 72, 75.
Paladin mucronatus, Weller, 1936, Jour. Paleontology, vol. 10, no. 8, p. 707.

Remarks.—More than 150 trilobite specimens (mostly incomplete) are referable either to this species or to *Kaskia chesterensis* J. M. Weller. Although a diligent search was made for specimens referable either to *Griffithides* sp. or to *G. pustulosus* Snider (both previously reported from the Pitkin), nothing typical of these forms has been seen. References in synonymies, therefore, can scarcely contain proper listing of these doubtful reports, because their true identity cannot be established at present.

⁷ Correspondence, April 15, 1940.

LOCALITY LIST

3. Shale and argillaceous limestone in reentrant near top of Pitkin on south side of outlier in NW $\frac{1}{4}$ sec. 35, T. 16 N., R. 30 W.
4. Massive ledge of limestone at top of Pitkin Bluff on east side of Fayetteville Country Club, 300 yards south of clubhouse.
5. Coarsely crystalline limestone from which spring flows across highway, due west of quarry at Cane Hill, Arkansas.
6. Very impure limestone and shale in small quarry on downthrow side of fault in road cut on hill 0.52 mile east of postoffice at Leslie, Arkansas.
7. Impure limestone under rock shelter at bluffs above Highway 71, $\frac{3}{4}$ mile southeast of West Fork, Arkansas.
8. Near top of Pitkin on north side of valley, $\frac{1}{4}$ mile east of road, 1 mile south of Cane Hill, Arkansas, in SE $\frac{1}{4}$ sec. 8, T. 14 N., R. 32 W.
10. Nodular limestone 24 inches thick, with shale near base of Pitkin in bluff north of road at gully near foot of hill northeast of Limestone, Arkansas, in NW $\frac{1}{4}$ sec. 8, T. 14 N., R. 21 W.
15. Upper impure limestone bed at bluffs above Highway 71, $\frac{3}{4}$ mile southeast of West Fork, Arkansas.
16. Near top of coarse crystalline limestone at top of Pitkin in quarry at Cane Hill, Arkansas.
17. Black shale layer one-half inch thick in lower part of Pitkin in quarry at Cane Hill, Arkansas.
20. Near top of Pitkin in SE $\frac{1}{4}$ sec. 8, T. 14 N., R. 32 W.
23. Upper part of Pitkin at small dry creek 2 miles east of Watts, Arkansas.
24. Limestone flat on east bank of War Eagle Creek, 100 yards south of bridge south of Huntsville in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 16 N., R. 26 W.
25. Middle of Pitkin in bluffs above Highway 71, $\frac{3}{4}$ mile southeast of West Fork, Arkansas.
26. Middle of Pitkin in bluff traversed by gully heading at southwest corner of school yard at Iceledo, Arkansas.
29. Red-speckled Pitkin at base of bluff north-west across road from "big spring" north of Cane Hill, Arkansas.
30. Thick shale above first massive limestone in quarry west of road, 0.3 mile south of Leslie, Arkansas.
32. Lower part of Pitkin in creek across bluff southeast of Hurley quarry, northeast of Leslie, Arkansas.
35. Fine-grained, thin bedded limestone at base of Pitkin in low road cut on west side of road on mountain south of Jasper, Arkansas.
37. White, finely oolitic limestone at bluffs above Highway 71, $\frac{3}{4}$ mile southeast of West Fork, Arkansas.
42. Argillaceous limestone in middle of Pitkin in bluffs above Highway 71, $\frac{3}{4}$ mile southeast of West Fork, Arkansas.
48. Fine-grained grey limestone above road cut at fault 0.52 mile east of postoffice at Leslie, Arkansas.
- 1379 blue. Harrison quadrangle, Fodderstack Mountain. Pitkin limestone. Miser, 1914.
- 1388 blue. Eureka Springs quadrangle, East border of sec. 21, T. 16 N., R. 27 W., Miser, 1914.
- 1389 blue. Eureka Springs quadrangle, sec. 30, T. 16 N., R. 28 W., Miser, 1914.

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